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☞ An asterisk (*) denotes an illustrated article

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WISHING TO MAKE THIS JOURNAL an organ of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, the publishers solicit letters from all among them who make the study of these subjects a pleasure, or a profession.

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FIFTH ANNUAL MEETING OF THE AMER. GAS LIGHT ASSOCIATION.

The fifth annual meetinng of the Association will be held at Cincinnati, O., on Wednesday, Oct. 17, 1877. Headquarters will be at the Gibson House on Walnut St. between 4th & 5th where arrangements have been made for the members at special reduced rates per day.

The meetings will be held in Gas Hall, corner of 4th and Plum Sts. Members are requested to prepare papers on any subject connected with gas matters, and to confer with the Secretary concerning the same. CHAS. NETTLETON, Sec'y.,
117 Broadway, New York.

DINNER GIVEN TO MR. WILLIAM KING OF LIVERPOOL.

Mr. William King, M.Inst.C.E., and Engineer of the Liverpool United Gas-Light Company, has been spending a few weeks in this country, visiting points of interest, and making a rapid tour to Niagara, Canada, the White Mountains, and Washington. His visit was necessarily very limited, much to the regret of all who have had the good fortune to meet him. The relations existing between the old New York and Manhattan Companies and the Liverpool Company, in early days, when the latter was conducted by that eminent engineer, Mr. Alfred King, the father of Mr. Wm. King, rendered it peculiarly fitting that a tribute of respect should be paid to him, and the dinner at the Hoffman House, on the 11th, was the result.

About thirty-five gentlemen were present. General Charles Roome presided, and on his right sat the honored guest of the evening. The dinner itself was a superb one. At one end of the table was a model of the large holder of the New York Company, at the other a representation of the scrubber towers of the Manhattan, while in the centre was a perfect representation of a King's Pressure Gauge. As the evening wore on, and the more substantial duties of the hour had been well-performed, General Roome arose and introduced Mr. King as follows—

ADDRESS OF WELCOME.

Gentlemen:

We have assembled for the purpose of manifesting our respect and regard for a gentleman who holds a high and honored position in our profession, and whose presence among us we hail with delight.

Twenty-seven years ago I visited Liverpool for the first time. There I met the father of our honored guest, with whom I had corresponded for some time, and with whom I was anxious to discuss matters which, as the engineer of my company, I felt it to be important that I should know, and which I could not learn from books or from intercourse with those who, at that time, in this country, regarded gas-making as a question of pure science. I was very cordially received, and most hospitably entertained, by that eminent engineer and accomplished gentleman.

His name is familiar to every one of you. You cannot walk through your works—you cannot sit down in your libraries and read what has been recorded since that day, of results obtained and principles established, you cannot pursue your investigations in your laboratories without being reminded of the debt of gratitude which you, and all who seek to obtain legitimate results, owe to the labors of that truly eminent and good man, Alfred King. He was a gentleman in the fullest acceptation of the term. I knew him well, and loved him dearly.

His son is with us now—then he was a gentle lovable boy. Seven years after I saw him again, and remember well the interest he took in the conversations that passed between his father and myself, and then I felt assured he would prove, as he has proved, that he was worthy of such a father, and would be fully qualified to fill his place when, in the good providence of God, he would be required so to do.

Gentlemen; some of you have met Mr. King in his own home. You know him, you know the estimation in which he is held, you cannot, perhaps, love him as much as I do for, in the distinguished Engineer and accomplished Christian gentleman, whose reputation is not confined to his own country, I see the son of one who honored me with his friendship, and whom I looked up to reverently as a wise counsellor and guide. To those of you who meet him now for the first time I say—cherish him as one of the brightest ornaments in our profession, one of the noblest of men.

Gentlemen; I propose the health of William King.

The address was often interrupted with applause, and, the toast having been drank most heartily, Mr. King replied in a most felicitous manner. He said that 21 years ago he entered his apprenticeship, and the very first lesson taught him by his father was that there was nothing impossible; but he really felt that, for the first time, he must say that he had found an impossi-

bility here, and that was to adequately express his gratitude for all the kindness shown him from the moment he landed, when kind friends stood ready to welcome him, to the present hour when he met the culmination of all that had gone before in the honor done him, and the tributes of respect, affection, and esteem paid to his honored father. It had long been his ambition to visit America; but he had never expected to be received as he had been. He was proud to stand among us as a representative of the Institution of Civil Engineers, and also as a representative of the gas interests of Great Britain. The men like himself to whom those interests were confided watched with deep interest the progress of America, and the development of their common interests here. After speaking of the mutual relations of friendship and regard existing between England and America, Mr. King, in a most heartfelt manner, returned his thanks for all the kindness he had received, and proposed the health of the New York and Manhattan gas companies, success and prosperity to the two companies, and long life to their presidents, General Roome and Mr. Lees.

To this Mr. Lees replied in fitting terms, and then followed many other sentiments and replies. The evening was one long to be remembered, and throughout the assemblage there was regret that the hour arrived for parting. Mr. King sailed on Saturday, by the Germanic, and in wishing him God speed and *bon voyage* it is with the hope that America may be honored with another, and a longer, visit from him. It was with extreme regret that Mr. King was obliged to decline an invitation to be present at the Cincinnati Meeting, but important business engagements at home prevented.

CITIZENS GAS-LIGHT CO., BROOKLYN.

We learn that Captain W. H. White has resigned the position of Engineer of this company, and that Dr. Thomas O'Connor Sloane, from the New York Gas Works, has been selected to fill the vacancy.

Mr. William Richards' Treatise on Gas Manufacture.

In our issue of Sept. 17th a figure was dropped out from the price of the above work, as advertised on page 132, making it $1 instead of $12. This typographical error would make quite a difference in the cost of the work, which was not intended on our part, and we correct it at once, lest any should be deceived in ordering the book.

Cantor Lectures.
The Chemistry of Gas Manufacture.

By A. Vernon Harcourt, Esq., M.A., F.R.S.
Lee's Reader in Chemistry at Christ Church, Oxford, and one of the Metropolitan Gas Referees.

[From the London Journal of the Society of Arts.

Lecture III.—Monday, March 19.

There is one other point I wish to refer to—namely, the effect of carbonic acid in gas upon the purification of gas from sulphur by the action of calcium sulphide. It was pointed out a few years ago, I believe by more than one person at about the same time, that the main reason why the purification of gas from sulphur by the action of lime showed so great a want of uniformity was, that the calcium sulphide—the chief purifying agent—was liable to be decomposed by the carbonic acid of the gas. What was necessary for effective purification was, that the lime should be used in sufficient quantity to remove the carbonic acid wholly in the first purifiers, so that the succeeding purifiers should contain undecomposed calcium sulphide, which would then retain the bisulphide of carbon.

I made, at that time, some experiments upon the effect of carbonic acid on calcium sulphide which had been used to purify gas from sulphur, and the results may still be of interest. I first prepared some calcium sulphide, and used it to purify gas, which it did very effectually, down to 10 or 12 grains per 100 cubic feet for some weeks together, the carbonic acid in the gas being carefully removed before the gas entered the tube filled with calcium sulphide. I then allowed gas containing carbonic acid to pass through and pushed the experiment further by adding carbonic acid to the gas. The issuing gas then contained a very large quantity of sulphur indeed. The gas freed from carbonic acid showed only some 10½ grains per 100 cubic ft. When I passed through the same material gas to which I had added a little carbonic acid, I found 68½ grains per 100 cubic feet. I pushed the experiment further, adding a larger quantity of carbonic acid, and found 135 grains of sulphur. With still more carbonic acid I got as much as 245 grains of sulphur given off.

Crude coal gas may occasionally contain a considerable quantity of carbonic acid. So there can be no doubt that the cause assigned for the fluctuations in the amount of sulphur, when lime was used unmethodically or in insufficient quantity, is a true cause, and that the very large quantities of sulphur sometimes found in gas result from carbonic acid being allowed to go forward in the lime purifiers, and so set free the sulphur which has been removed by the lime from a previous quantity of gas.

In the next and concluding lecture I propose to speak of those ingredients of coal gas which are most important for their heating and illuminating properties.

Lecture IV.—Monday, March 26.

In the preceding lectures, I have dealt with those products of the destructive distillation of coal which are mainly eliminated in the course of the manufacture of coal gas, and I have to speak to-night of those substances which are the ingredients of purified coal gas. In the table on my right there are given the results of the analyses of various samples of coal gas, made some years ago by Dr. Frankland. The figures show that the principal constituents are two—hydrogen and marsh gas. The relative proportions of hydrogen and marsh gas vary to some extent, but, as a rule that of hydrogen is the larger, so that an average sample of coal gas contains nearly 50 per cent. of hydrogen, and about 36 per cent. of marsh gas. The proportion of the gas next in amount, namely, carbonic oxide, is much smaller, generally about 8 per cent. Next comes a group of constituents—comparatively small in quantity, but chief in importance—olefiant gas and its homologues, which may be regarded as condensed forms of olefiant gas, and of these the proportion is about 5 per cent.

I have here some bottles filled with these principal ingredients of coal gas—hydrogen, marsh-gas, carbonic oxide, and olefiant gas. They are all as colorless and transparent as air. I will endeavor, in the first place, to show you some of the differences in their properties, and, in the next, to effect the synthesis of coal gas, by mixing them in the proportions in which they are found to co-exist. I pour hydrogen from this bottle upwards, through the water of the pneumatic trough, into a bell-jar, which is fitted with a batswing burner on the top, so that I may be able to judge of the difference in their illuminating power. I will pass up sufficient of each to show you the kind of flame which the gas produces; and, as I shall burn them all under the same pressure, and with the same burner, you will be able to judge of the difference in their illuminating power. I have now some hydrogen in a jar, and by depressing the jar into the water of the pneumatic trough, I have put it under pressure, and on lighting it you see the kind of flame with which hydrogen burns—a flame of very high heating power, but by itself of very small illuminating power. You see how colorless and non-luminous it is, but also to what intense brightness it ignites a coil of platinum wire which I hold in it.

Now I will repeat the experiment with marsh gas. Here you see I have, as compared with hydrogen, a gas burning with considerable illuminating power; and although the gas, which has been prepared in the ordinary way, by heating together soda-lime and sodium-acetate, is probably not perfectly pure, and the illuminating power may be somewhat greater than it would be with pure marsh gas, yet I have never seen a sample of marsh gas which had not some illuminating power; and I think, therefore, the statement frequently made, that marsh gas is to be regarded, like hydrogen and carbonic oxide, simply as a diluent of coal gas, combustible, but not luminiferous, must be accepted with some reserve.

Next, I will take the carbonic oxide. There you have the characteristic blue color, and a scarcely luminous flame. In this case, as in the case of of hydrogen, I may show you that this non-luminous flame has an exceedingly high heating power, by holding it in the spiral of platinum wire.

I have still one other of these principal ingredients to examine—namely, olefiant gas; but while that is being brought into the bell-jar, I may pass on to the consideration of the heat which is produced by the combustion of these gases. I have a table here, which Dr. Frankland has kindly lent me, showing some of the different effects of burning marsh gas, carbonic oxide, and hydrogen. There is a difference, though not an important one for any practical purpose, between the quantities of oxygen which are consumed by the three, marsh gas consuming four times as much oxygen as is consumed by either carbonic oxide or hydrogen, the two latter consuming the same amount.

As to the carbonic acid generated, marsh gas and carbonic oxide both produce their own volume of carbonic acid, while hydrogen, of course, produces none. There is also a difference in the amount of heat that is generated by the combustion of equal volumes of these three gases. One cubic foot of marsh gas, measured under standard conditions—that is, at a temperature of 60° Fahr., and under a pressure of 30 inches of mercury—will heat by its combustion 6 lbs. of water from freezing point to boiling point. One cubic foot of carbonic oxide would heat 2 lbs. of water through the same range of temperature—that is, it produces only one-third the amount of heat which is produced by the combustion of an equal volume of marsh gas. Lastly, the heating power of hydrogen is very nearly the same as that of carbonic oxide, comparing, of course, volume with volume, not weight with weight.

Now I will return to the experiment with the olefiant gas, and you see that I have here a gas which really is too powerfully illuminating to be burnt in such a burner; that is to say, it gives a brilliant light, but burns with a smoky flame, and the full illuminating value of it is not developed.

Although I think marsh gas should not be regarded as being, like hydrogen and carbonic oxide, merely a combustible diluent, yet no doubt the principal source of the illuminating power of coal gas is the relatively small proportion of olefiant gas which it contains.

Now I will make from the residues of these gases, which remain in the bottles, a mixture to represent coal gas. I mix, first, these three having least illuminating power—the hydrogen, the marsh gas, and the carbonic oxide; and I will show you what amount of light is obtained by burning a mixture of these three gases in themselves. Then I will add the proper dose of olefiant gas, 5 per cent. or so, which coal gas ordinarily contains, and show the difference in the illuminating power thus produced. I have now about one-half the bell-jar full of hydrogen; next, I put in marsh gas to about one-third of its capacity, and then about one-tenth of carbonic oxide. I cannot allow them much time for diffusion, but in a vessel of this diameter gases mix very rapidly; and I will now burn a little of the mixture as it is, this being in fact coal gas, *minus* olefiant gas. You see that we have a gas of very poor illuminating power. The illuminating power is not *nil*, but it is exceedingly small. I have here a cylinder on which I have measured off a volume which is one-nineteenth of the volume of this bell jar, measured down to the point to which it is now filled with the mixture of gases, so that if I pass up into the bell-jar the olefiant gas which this cylinder contains, I shall have added 5 per cent. of olefiant gas to the mixture, whose illuminating power you have already seen. I must allow it a few moments for diffusion, and in this case I cannot freely stir the gases together by agitating the water beneath them, because olefiant gas is sensibly soluble in water. I now expel the mixture through the burner and light it, and you see that I have a gas which has about the ordinary illuminating power of coal gas.

I propose now to make a few observations upon the nature of flames. I have arranged here an experiment in order to illustrate this fact, that what we speak of as flame is a phenomenon occurring at the common surface of two gases capable of acting chemically one upon another, with the production of a temperature of incandescence, that incandescence being either the incandescence of a solid or of a gaseous substance. Thus we may either have coal gas or any other so-called combustible gas burning in the air, or we may have the gas which I have now succeeded in lighting, namely, air burning in coal gas.

I have fitted up a large lamp-chimney with a cork at each end. Two glass tubes pass through the lower cork; one, of a quarter of an inch in diameter, and five inches in length, is central, and rises one inch within the chimney; the other, by its side, passes just through the cork, and is connected with the gas supply. A third tube passes through the cork in the top of the chimney, and serves as outlet. I am sending, through the chimney, a slow stream of coal gas, which is now burning at the top of the apparatus. The coal gas within the chimney, being lighter than air, produces a small diminution of pressure towards the bottom, and therefore a slow current of air enters the chimney by the open tube. The jet of air thus produced, having been lighted at the end of the tube within the chimney, and being in an atmosphere of a gas with which it can combine, produces a flame in which air is the inside gas, and coal gas is the outside gas. Burning above is a flame differing from that below only in this respect, that common air is the outside gas, and the coal gas is inside; so that here we see two phenomena which are perfectly similar, although one is much more familiar than the other. You see the degree of resemblance between the two flames. There can be no doubt that if our constitution were such that we were capable of living in an atmosphere of coal gas, and if we were able to make from any material which would then correspond to coal, a gas having the nature of atmospheric air, we could lay it on and light our streets and houses with air as we now do with coal gas.

Now, the nature of flame being of this kind, there is a further question, and a very important question, as to the nature of luminous flames, and as to what is the common property to which different flames own their luminosity. In the case of what may be described as hydrocarbon flames, such as the flame of coal gas, the theory of Sir Humphrey Davy is, I believe, the true theory—namely, that their luminosity is due to the presence of solid carbon in the flame. It has been pointed out that there are examples of highly luminous flames in which there is no solid matter. If we burn a substance of which I spoke in my last lecture—carbon bisulphide—in an atmosphere of oxygen, we have an intensely luminous flame, although the substances produced—carbonic and sulphurous acids—are both at the ordinary temperature gases. Even in the case of one of the most brilliant of flames, that produced by the combination of phosphorus, the oxide of phosphorus at the high temperature at which it is formed is also gaseous; and there are some other highly luminous flames in which nothing solid is present. But there are also plenty of examples of flames, otherwise non-luminous, which are rendered luminous by the introduction into them of a solid substance.

In the case of the flame of a candle or of coal gas, a finely-divided solid substance is formed in the flame. At the high temperature which is produced by the burning of carbon and hydrogen in the outer zone of the flame, the gas which is still within this zone, and has not yet emerged into the air, or into the presence of a sufficiency of oxygen for its combustion, is decomposed and deposits its carbon; and it is to the ignition and incandescence of this carbon that the luminosity of the flame is due. In a word, what we see in the flame of coal gas or of a candle is soot heated to whiteness. I will try to illustrate this to you by a very simple experiment. I have here a Bunsen burner, burning with its well-known non-luminous flame, and I have placed round it a tray formed of a piece of stiff paper, on which there is a layer of lampblack. On shaking this paper, particles of the lampblack rise in fine dust, and pass through the opening for air at the bottom of the burner, and so rise in a fine carbonaceous cloud into the flame. You see that as long as the paper is shaken the flame is luminous, but as soon as the agitation ceases the flame burns as usual, in a non-luminous manner.

There is another experiment I need hardly make, it is so familiar. If we dip any cold substance into a luminous flame of coal gas or of a candle, a black carbonaceous coating is deposited upon it. No doubt that is not conclusive as to the presence of carbon in the flame. It might be the case that that which otherwise, at the high temperature of the flame is gaseous, becomes solid when it is brought into contact with the solid substance upon which it is deposited. Moreover, the deposit which is thus formed does not consist of pure carbon, but contains a certain amount of hydrogen. That, however, is also true of coke and charcoal, and of every portion of carbon which is produced by the ignition of a substance in which hydrogen was once united with carbon, however high the temperature applied may have been. When coal gas or any gaseous hydrocarbon is heated to redness in a glass tube, more condensed hydrocarbons—or what are called, with convenient vagueness, tarry matters—are formed and deposited. And if these tarry matters are strongly ignited, air being excluded, a solid residue always remains. These conditions exist in the interior of a gas-flame, and, apart from the evidence furnished by the deposition of soot on a cold object placed in the flame, it seems certain that a solid non-volatile hydrocarbon must locally and transiently be formed.

Now as to the conditions which render a flame of this kind more or less luminous. I have arranged here an experiment, for which I am indebted to Professor Heumann, which illustrates well the effect of a more or of a less rapid and intense combustion upon the flame of coal gas. I have a bottle of oxygen fixed in an inverted position, and I will burn a small jet of coal gas in the oxygen; and while it is burning, I will describe to you what I conceive to be the nature of the changes which occur. The first thing I wish you to observe is that the gas, which was burning in the air with a fairly long and luminous flame, when placed within the oxygen, gives a brighter point of flame, but so much smaller that on the whole the light emitted is less than it was before. But that light will continually increase—it is already greater than it was when the jet was first placed within the bottle. The flame grows in size, diminishing a little in whiteness and brightness, but increasing in the total amount of light which is given out, up to a certain point; and after that point has been reached and passed, then the flame continues to increase in size, but the total production of light again diminishes. Some interesting observations have been made upon this series of changes. In the first place it seems that the amount of light which is given by a coal-gas flame burning in air depends simply upon the degree of dilution of the oxygen with an indifferent gas, and that it is immaterial whether that gas is nitrogen, as it actually is in the case of air, or whether it is some other gas, such as carbonic acid. In any case the luminosity reaches its maximum when the proportion of the diluent gas is about that which it is in our own atmosphere—that is, about four parts of diluent to one of oxygen. You observe now that the flame, burning in a mixture of oxygen and carbonic acid, has very much the same appearance as it had when burning outside in the air. At this point, I believe, if an analysis of the gas were made, we should find that one-fifth of the gas remaining in the bottle was oxygen, and that four-fifths were carbonic acid or steam. But as dilution of the gas advances, the quantity of oxygen remaining in the bottle being progressively diluted with the products of combustion, the luminosity continually diminishes whilst the size of the flame increases, and we have at last a large flame wholly non-luminous.

There are, however, several other conditions upon which the degree of luminosity of a flame depends. One of these, which has been carefully investigated by Dr. Frankland, is the density of the atmosphere in which the gas burns. His experiments began with some observations which he made upon the combusion of candles at different heights. The same candles were burnt at Chamounix, and then at the top of Mont Blanc, and it was found that the rate of combustion was unaffected by the considerable difference of barometric pressure at these two different elevations; but it was observed that the luminosity of the candles was much less at the higher than it had

been at the lower level. The observations were afterwards carried further, by burning a jet of gas in an apparatus in which the atmospheric pressure could be varied at will. The general result, expressing by 100 the illuminating power observed at the ordinary pressure of 30 inches of mercury, was that, down to a pressure of 14 inches, each diminunition of one inch of barometric pressure produced a decrease in illuminating power of 5·1. Hence it follows that the ordinary variations of atmospheric pressure, amounting to two inches or more, must produce very appreciable differences in the illuminating power of the same gas. Or again, the same sample of gas burning in two towns at different levels, and thus, being under a different atmospheric pressure, will exhibit different illuminating powers.

Another condition is the temperature of the flame. Other things being equal, the illuminating power appears to be greater in proportion as the temperature of the flame is higher. An interesting experiment has recently been made by substituting for the brass tube with which Bunsen burners are ordinarily furnished, a platinum tube, which can be heated to redness without giving off any substance which will color the flame or render it luminous; when the gas is ligh ed, and the tube trough which it is passing is heated with a strong horizontal jet of flame from a blowpipe, the non-luminous flame becomes, to some extent, luminous. The explanation given is that a mixture of gas with so much air as to render it non-luminous at its normal temperature of combustion becomes luminous when the temperature of the flame is raised by a previous heating of the mixture. An alternative explanation, which naturally suggests itself, is that the change in the luminosity of the flame may depend, not upon the alteration in the temperature, but upon some change produced in the composition of the mixed gas and air by its being locally exposed to a high temperature previously to combustion. But it is said that if the gas, which, when it is burned immediately after it has been heated, gives a luminous flame, is conducted through a certain length of tube—so that it may have lost the high temperature without any further change in circumstances—and then is burnt, the flame is non-luminous as before. It is said also that tubes through which the gas is led no deposit is observable, as would be the case if the changes were due to the production and condensation of some tarry matter by the action of the high temperature on the mixture of gas and air.

[To be continued.]

Large Sewers in Buffalo.

A very important and extensive piece of sewerage work—known as the Mill Race and Fillmore Parkway Sewer—is now in process of construction in Buffalo, New York.

Its total length is 11,143 feet, the whole number of acres drained at the outlet being 4,562. The improvement is divided into six sections the size of the first being 12 by 9 feet, the second 10 by 6½, the third 7½ by 5 and egg-shaped, the fourth 7½ by 5, bench walls and arch, the fifth 7 feet by 4 feet 8 inches, egg shaped, and the sixth, 6 feet 3 inches by 4 feet two inches.

Work was begun about the first of last month, and some two hundred men are at present actively employed.

A. H. Delameter, of Cleveland, Ohio, is the contractor for the work, his bid of 78,000 being the lowest of the four which were received, a year's time being allowed for its completion from the date of its commencement. The work is under the general supervision of City Engineer, Geo. E. Mann, Assistant Engineer Edward B. Guthrie being directly in charge. —*Ibid.*

Official Report of Examinations of Illuminating Gas, for the week ending August 11, 1877, made at the Photometrical Room of the Department of Public Works.

Date.	Time.	Temperature of Thermometer.	Gas Company	Burner.	Pressure at Point of Ignition.	Consumption of Gas. Rate per hour.	Consumption of Candle, Grs. per hour	Illuminating Power. Observed.	Illuminating Power. Corrected.
1877.		Deg.			In.				
Aug. 6	4.30 P. M.	80	New York.....	Sugg-Letheby.....	.05	4.97	121.50	17.38	17.69
" 7	9 A. M.	80	"	"	.05	5.00	118.50	16.74	16.53
" 8	11.30 A.M.	83	"	"	.05	4.96	121.50	16.52	16.86
" 9	9.30 A. M.	84	"	"	.05	5.02	120.75	17.20	17.23
" 10	11.30 A.M.	83	"	"	.05	4.99	116.25	17.22	16.71
" 11	10.30 A.M.	82.5	"	"	.05	5.01	121.50	16.18	16.34
								Av'ge.	16.89
" 6	3 P. M.	79	Manhattan.....	"	.05	5.05	119.25	18.66	18.35
" 7	10 A M.	80.5	"	"	.04	5.02	117.00	20.84	20.23
" 8	12.30 P.M.	83.5	"	"	.05	4.98	118.50	19.68	19.51
" 9	10 A. M.	84	"	"	.05	5.00	124.50	17.52	18.16
" 10	3.30 P. M.	84	"	"	.05	4.98	117.00	19.92	19.49
" 11	10 A. M.	82	"	"	.05	5.00	124.50	17.84	18.50
								Av'ge.	19.04
" 6	2.30 P. M	79	N. Y. Mutual.....	"	.04	4.07	119.25	16.60	20.25
" 7	11.30 A.M.	81.5	"	"	.05	4.01	117.20	18.38	20.33
" 8	9.30 A. M.	82	"	"	.05	4.12	121.50	18.08	22.20
" 9	11 A. M.	84	"	"	.05	4.09	117.75	16.56	19.85
" 10	9.20 A. M.	82	"	"	.05	4.05	118.50	17.98	21.91
" 11	11.30 A.M.	83	"	"	.05	4.26	121.50	17.22	20.45
								Av'ge.	21.16

For the Week Ending August 18, 1877,

Aug. 13	10.30 P.M.	85	New York.....	Sugg-Letheby.....	.05	4.98	117.00	17.60	17.22
" 14	10.30 A.M.	83	"	"	.05	5.04	120.00	16.06	15.93
" 15	4 P. M.	82.5	"	"	.05	5.03	118.50	17.18	16.86
" 16	10.30 A.M.	81.5	"	"	.05	5.10	124.50	16.22	16.49
" 17	12 M.	82	"	"	.05	4.94	119.40	16.60	16.71
" 18	10.30 A.M.	81	"	"	.05	5.00	120.00	16.32	16.32
								Av'ge.	16.59
" 13	9.30 P. M.	85	Manhattan.....	"	.05	5.02	117.00	19.66	19.09
" 14	12 M.	84	"	"	.05	5.01	118.50	19.34	19.05
" 15	5.30 P. M.	83	"	"	.05	4.95	120.00	18.38	18.56
" 16	9 A. M.	81	"	"	.05	5.00	120.75	18.56	18.67
" 17	11 A. M.	81	"	"	.05	5.04	120.60	17.66	17.60
" 18	8.30 A. M.	80	"	"	.05	5.00	118.80	18.60	18.41
								Av'ge.	18.56
" 13	8.30 P. M.	83	N. Y, Mutual.....	"	.05	4.10	117.00	17.22	20.47
" 14	1.30 P. M,	84.5	"	"	.05	4.20	118.50	17.16	20.16
" 15	3.30 P. M.	82	"	"	.05	4.61	123.00	17.10	19.01
" 16	11.30 A.M.	82	"	"	.05	4.16	120.00	17.62	21.18
" 17	9 A. M,	80	"	"	.05	4.41	117.00	18.66	20.62
" 18	11 A. M.	81.5	"	"	.05	4.40	119.40	17.60	19.90
								Av'ge.	20.22

E. G. LOVE, Gas Examiner.

Official Report of Examinations of Illuminating Gas, for the week ending August 25, 1877, made at the Photometrical Room of the Department of Public Works.

Date.	Time.	Temperature of Thermometer.	Temperature of Barometer.	Gas Company.	Burner.	Pressure at Point of Ignition	Consumption of Gas Rate per hour.	Consumption of Candle, Grs. per hour.	Illuminating Power. Observed.	Illuminating Power. Corrected.
1877.		Deg.				In.				
Aug. 20	12 M.	82.5	30.05	New York.....	Sugg-Letheby.....	.05	5.01	122.40	16.64	16.95
" 21	5.30 A.M.	84	30.10	"	"	.05	5.00	117.00	17.04	16.61
" 22	12 M	83	30.13	"	"	.05	4.98	121.20	16.84	17.07
" 23	10.30 A.M.	83	30.12	"	"	.05	5.14	119.40	16.88	16.33
" 24	5 P.M.	85	30.11	"	"	.05	4.98	117.00	16.52	16.17
" 25	10 A.M.	84.5	30.06	"	"	.05	4.94	117.00	15.48	15.27
									Av'ge.	16.40
" 20	10.30 A.M.	82	30.05	Manhattan.....	"	.05	5.08	117.00	18.44	17.69
" 21	4.30 P.M.	82	30.10	"	"	.05	5.03	117.00	17.91	17.36
" 22	10 A.M.	82.5	30.13	"	"	.05	5.00	120.00	17.96	17.96
" 23	9.30 A.M.	82	30.12	"	"	.05	4.92	117.00	18.20	18.03
" 24	5.30 P.M.	84.5	30.19	"	"	.05	4.42	117.00	18.08	17.91
" 25	9.30 A.M.	84	30.06	"	"	.05	4.93	117.00	17.80	17.60
									Av'ge.	17.76
" 20	1 P.M	83.5	30.05	N. Y. Mutual.....	"	.05	4.27	124.20	15.60	18.90
" 21	6 P.M.	85	30.10	"	"	.05	3.88	123.00	14.84	19.60
" 22	4 P.M.	83.5	30.09	"	"	.05	4.20	120.00	16.96	20.19
" 23	11 A.M.	83	30.12	"	"	.05	4.06	121.20	16.20	20.13
" 24	3 P.M.	83.5	30.11	"	"	.05	3.94	117.00	15.16	18.75
" 25	11 A.M	85	30.06	"	"	.05	4.08	117.00	15.80	18.87
										19.40

For the Week ending September 1. 1877.

Aug. 27	6.30 P.M.	83	30.23	New York.....	Sugg-Letheby.....	.05	5.08	120.00	16.64	16.37
" 28	4 P.M.	84.5	30.18	"	"	.05	5.05	121.20	16.88	16.88
" 29	3.30 P.M.	86	30.00	"	"	.05	5.05	124.20	16.52	16.91
" 30	3 P. M.	85	30.07	"	"	.05	4.97	120.00	16.88	16.98
" 31	1 P.M.	83.5	30.09	"	"	.05	5.06	124.20	16.22	16.57
Sep. 1	2 P.M.	83	29.81	"	"	.05	5.02	120.75	16.58	16.62
									Av'ge.	16.72
Aug. 27	2.30 P.M.	83	30.23	Manhattan.....	"	.05	4.98	117.00	17.12	16.75
" 28	2.30 P.M.	83.5	30.18	"	"	.05	4.96	121.80	16.48	16.86
" 29	2.30 P.M.	85.5	30.00	"	"	.05	4.92	120.00	17.64	17.92
" 30	2.30 P.M.	84	30.07	"	"	.05	4.97	123.00	16.60	17.11
" 31	12 30 P.M.	83	30.09	"	"	.05	4.97	123.00	17.26	17.79
Sep. 1	1-30 P.M.	82	29.81	"	"	.05	4.98	120.00	17.46	17.52
									Av'ge.	17.32
Aug. 27	4 P.M.	84	30.23	N. Y. Mutual.....	"	.05	4.38	117.00	16.76	18.65
" 28	5 P.M.	85	30.18	"	"	.05	4.14	117.00	16.45	19.36
" 29	4 P.M.	86	30.00	"	"	.05	4.11	117.90	16.04	19.16
" 30	4 P.M	85	30.07	"	"	.05	4.25	121.20	16.80	19.95
" 31	1.30 P.M.	84	30.09	"	"	.05	4 34	123.75	15.64	18.58
Sep. 1	2.30 P.M.	83.5	29.81	"	"	.05	4.22	120.00	16.21	19.20
									Av'ge.	19.15

F. G. LOVE, Gas Examiner.

Report of the Department of Public Works for the Quarter Ending June 30, 1877, Bureau of Lamps and Gas.

DEPARTMENT OF PUBLIC WORKS,
BUREAU OF LAMPS AND GAS
NEW YORK, JULY 5, 1877.

HON. ALLAN CAMPBELL,

Commissioner of Public Works;

Sir: In accordance with the provisions of section 27, chapter 335 of the laws of 1873 (the City Charter), I submit the following report showing the transactions of the Bureau of Lamps and Gas, for the three months ending June 30, 1877:

In Exhibit "A" will be found an abstract of all vouchers certified during the quarter. Exhibit "B" is a statement showing the amounts expended for gas to the several public markets, offices, etc., and for fitting up, repairing and lighting the public lamps, etc. Exhibit "C" is a summary of the appropriation for "lamps and gas" for 1877, showing an expenditure during the quarter of one hundred and sixty-two thousand seven hundred and fourteen dollars and thirty-eight cents ($162,714.38), and for the six months of two hundred and ninety-three thousand one hundred and twenty-seven dollars and ninety-one cents ($293,128.91) with the list of liabilities for lighting public la[illegible], etc., for the month of June, amounting to fifty-one thousand two hundred and twenty-six dollars and thirty-six cents ($51,226.36), leaving an available balance of three hundred and eighty thousand six hundred and forty-five dollars and seventy-three cents ($380,645.73). Exhibit "D" is a summary of the "Lamp Account," and shows the number of new lamps lighted, old lamps relighted, and lamp discontinued by each gas company during the quarter, and the total number of lamps burning under the supervision of the Department of Public Works, on June 30, to be twenty thousand six hundred and six.

The painting of the lamp-posts and lanterns is now being done by the several gas companies in accordance with that specification of the contracts which requires that this work shall be done once during the year, and between the first day of May and the first day of November. A great improvement in the condition of the public lamps can already be seen; the lamps of the Manhattan Company being especially notable for their neat and glossy appearance, and the increased amount of light afforded by the clear white paint on the inner side of the lantern.

The resolution of the Common Council directing that lamps be placed at regular distances on the Third avenue, from Westchester avenue to the northern boundary of the Twenty-third ward, has been complied with by the erection of forty-eight new lamps, and the removal and resetting of thirty-one old lamps at their proper places. This avenue is now lighted its entire length, from Harlem river to the northern limits. New lamps have also been erected in Mott avenue, in the above ward, by direction of the Common Council, which completes the lighting of the same.

In view of the accidents which have occurred on the river-fronts the Common Council has adopted a resolution directing that lamps be erected and lighted on the public piers, the some to be done by this Department in co-operation with the Department of Docks. Deeming it essential that lights should be placed on the piers, or at least on those used for passenger landings, the Department of Docks has been notified that the Bureau of Lamps and Gas is ready, at any time, to perform its portion of the work. As the piers, however, are under the exclusive care and control of the Department of Docks, of course the Department of Public Works can do nothing toward the lighting until the necessary action is taken by the former Department, which, I learn, is about being done.

A petition having been received by you from the property-owners and residents of Riverdale, in the Twenty-fourth Ward (prior to annexation of the town

of Kingsbridge), requesting that lamps be erected and lighted at said place, and the same having been referred to this office for examination and report, I visited all the streets and places of that locality and found there many valuable residences and two churches, with not a solitary street lamp in the place, although gas-mains had been laid by the Yonkers Gas-light Company some fifteen years ago. The streets and roads were exceedingly dark in consequence of the heavy foliage of the trees in the court-yards and gardens; and driving at night was quite difficult and perhaps dangerous. Deeming, therefore, that light was absolutely necessary, both for the protection and comfort of the inhabitants, I recommended that from fifty to seventy-five lamps be erected, and this having met your approval, proposals for the same were received by the Gas Commissin on the 2d inst. When the award is made and the contract executed I will proceed to the erection of the lamp-posts in order that the lamps may be lighted on the 16th instant or within a few nights thereafter.

The inspectors of this bureau have made a thorough examination of all the corner lamps throughout the city, for the purpose of ascertaining the number and names of street signs required. These useful guides have all been ordered and a portion has been delivered, but I have not deemed it prudent to place the same in the lanterns while the painting was being done. Within the next two weeks the painting will have been completed, and then the lanterns will appear with a fresh dress of bright paint and the full complement of street signs.

I have given considerable attention to the naphtha lamps, twenty-one hundred in number, which are lighted in that section of the city lying north of Seventy-ninth street and east of Third avenue, and while I find a good light on calm nights, although, of course, not equal to gas, yet I am not satisfied as to their cleanliness, and, in consequence of the glass not being cleaned as frequently and as thoroughly as is necessarily required for these lamps, much of the light is inevitably lost. The attention of the contractor has been called to this matter, and I am promised that the lanterns shall receive better care in the future. A regular record is kept of all these lamps which are reported by the police as not burning, and a reduction is made therefor from the monthly bills.

On March 27 last, a resolution was adopted by the Common Council, and approved by his Honor the Mayor on April 4, directing that suitable rooms be "procured on Grand street and also on Seventy-ninth street, and that the same be properly fitted up with the necessary apparatus for testing the illuminating power of the gas supplied to the city by the several gas-light companies, and the consuming capacity of the burners supplied to the public lamps."

In accordance with the directions contained in said resolution a suit of two rooms has been obtained in the building known as "Odd-Fellows Hall," situated on the southeasterly corner of Grand and Centre streets. These rooms have been fitted up in the most thorough and perfect manner with apparatus manufactured expressly for this city, the strictest attention having been given to every detail in order that the results may be accurate in every respect and beyond dispute. At this place every question in regard to the specific gravity, quality and candle-power of illuminating gas, can be determined, as well as the consuming capacity of gas-burners and the correctness of a meter-prover, or an experimental or test meter. At the same time the question of pressure has not been overlooked, inasmuch as pressure registers have been set by which the pressure on the mains of the several gas companies is constantly recorded. The adjusting and testing of the apparatus will be completed in the course of the ensuing week, and then regular daily observations will be made and the reports will be furnished weekly to the CITY RECORD in connection with the several weekly reports of this Bureau.

At the above-mentioned rooms the gases of New York, Manhattan, Mutual and Municipal Gas Companies can be examined. I have been unable, thus far, to obtain a suitable place on Seventy-ninth street (for the gases of the Harlem and Metropolitan Companies), but expect to procure one during the ensuing month. When rooms are fitted up on this street the public will be aware of the quality of the gas manufactured by all the gas companies of this city, and this Department will have the satisfaction of knowing, through its own resources, whether the contracts of the several gas companies are strictly compiled with. I had proposed to give a description of the different apparatus already fitted up, and the several uses for which they are to be applied, but, inasmuch as the same has not yet been adjusted and tested, I will defer doing so until my next quarterly report.

In my report of the 31st December last, I gave a synopsis of all the grants or franchises authorizing the laying of gas mains in this city up to that date. Since then, permission has been given a new company, styled "the Municipal Gas-light Company," for the laying of mains in all the streets throughout the city, and the permission so given is hereto annexed as Exhibit "E."

All of which is respectfully submitted,

S. McCORMICK,
Superintendent of Lamps and Gas.

EXHIBIT "D."

Summary of the Lamp Account, showing the number of New Lamps Lighted, Old Lamps Relighted, and number discontinued by each Gas Company, during the Quarter ending June 30, 1877.

COMPANY.	Number of Lamps burning March 31, 1877.	Number of New Lamps lighted during quarter ending June 30, 1877.	Number of Old Lamps relighted during quarter ending June 30, 1877.	Number of Lamps transferred during quarter ending June 30, 1877.	Less Lamps discontinued during quarter ending June 30, 1877.	Total number of Lamps burning June 30, 1877.
New York	2,452		1	561	1	3,013
Manhattan	4,125	56	1	2,389	14	6,557
Metropolitan	3,742	23	16		15	3,766
Harlem	4,068	57	11	2,085	35	2,016
New York Mutual	3,536			2,950		586
New York and New Jersey Globe		6	17	2,085		2 108
Central	1,542	48			3	1,587
Suburban	973					973
Total	20,438	190	46	10,070	68	20,606

EXHIBIT "E."

Whereas, The following resolution has been adopted by the Common Council and approved by his Honor the Mayor, to wit:

Resolved, That permission be and is hereby given to all incorporated gas-light companies to lay gas-mains and pipes in the streets, avenues, and public places in this city for the purpose af supplying gas to this city and its inhabitants, upon such conditions as may be prescribed and approved by his Honor the Mayor, the Comptroller, and the Commissioner of Public Works, who are now by law authorized to make provision for lighting the streets of this city.

Adopted by the Board of Aldermen, Dec. 21, 1876.
Approved by the Mayor, Dec. 23, 1876.

(Signed) F. J. TWOMEY,
Clerk of the Common Council.

And whereas, The "Municipal Gas-Light Company," a gas-light company duly incorporated, desires to avail itself of such permission, upon conditions to be prescribed and approved, as in said resolution provided:

Now, we, the Mayor, Comptroller, and Commissioner of Public Works, of the city of New York, in pursuance of the foregoing resolution, do hereby prescribe and approve the following as the conditions upon which the said Municipal Gas-Light Company may lay its gas-mains and pipes in the streets, avenues, and public places in the city of New York, for the purpose of supplying gas to the city and its inhabitants, namely:

First—The manufactory or works necessary for the purpose of producing and furnishing gas shall be so conducted as not to be in any way detrimental to the health, nor otherwise create a nuisance.

Second—The gas furnished shall be of the best quality of illuminating gas, and of an illuminating power of not less than sixteen candles when tested at a distance of not less than one mile from the place of manufacture.

Third—Gas shall be supplied to the public lamps situated on the line or lines of the mains of said company, and said lamps shall be lighted, when required by the city, at a rate not to exceed the maximum of twenty dollars per annum for each lamp, burning thirty-eight hundred and thirty three and one-third hours and consuming gas through a burner consuming three feet of gas per hour under a pressure of one inch; the said rate to include the gas, lighting, extinguishing, cleaning, repairing, reglazing, and painting the lamp-posts and lanterns, replacing the cocks, tubes, burners, crossheads, lamp-irons and lanterns.

Also, the prices for fitting up and repairing lamp-posts, which may at any time be required, shall not exceed the following rates, to wit:

For fitting up each lamp-post, ten dollars.

For straightening each lamp-post, one dollar and fifty cents.

For releading each column, one dollar and fifty cents.

For refitting each column, three dollars and fifty cents.

For removing each lamp-post three dollars and fifty cents.

For resetting each lamp-post, ten dollars.

Fourth—If at any time during the continuonce of the permission given by said resolution of the Common Council, it shall be considered by the Commissioner of Public Works, that the cost of production tion or manufacture of gas shall be reduced to an extent to admit of the lighting of the public lamps at a rate less than twenty dollars per annum, then in that case, arbiters shall be appointed, one by the parties of the first part, one by the parties of the second part, and the two so appointed to designate a third, which three shall determine upon a fair and equitable rate below the said twenty dollars.

Fifth—Gas shall be supplied to the public buildings or offices of the Corporation situated on the line or lines of the mains of said parties of the second part, whenever the said company may be required so to do, by the proper officers of the city, at a rate not to exceed two dollars per one thousand feet.

Sixth—From and after the first day of January, 1878, gas shall be supplied to all persons residing or doing business on the line or lines of the mains of the parties of the second part, who may desire the same at a rate not to exceed two dollars and forty cents per one thousand cubic feet; and no consumer shall be deprived of gas upon refusal to pay or in consequence or on account of a dispute as to the bill rendered, un

til such consumer shall have been served with an affidavit of the Inspector of the said company as to the correctness of the register of the meter through which such gas has been passed. Provided that, leaving such affidavit upon the premises where gas has been furnished, with some person of suitable age and discretion, shall be a sufficient service thereof on such customer.

Seventh—The Common Council of the city of New York shall have the right to order the mains or pipes of said company to be extended in or along any of the streets, avenues, or public places of the city, provided that said parties of the second part shall not be compelled to expend in the laying of mains a yearly sum exceeding ten thousand dollars,

Eighth—All trenches or excavations shall be filled immediately after the mains or pipes shall be laid, the earth to be thoroughly rammed as the same is thrown into the trench or excavation, and the pavement to be replaced in a good and workmanlike manner, and to the entire satisfaction of the Commissioner of Public Works; and in case the said company or its successors, shall fail or neglect to replace the pavement or pavements to the satisfaction of the Commissioner of Public Works, then the Commissioner of Public Works shall have the right to cause such pavement to be taken up and replaced in a good and workmanlike manner, by a person or persons to be appointed by the said Commissioner for that purpose; and the expense of such repaving shall be paid by the said parties of the second part to the Commissioner of Public Works-

Said company shall also be governed by the laws and ordinances of the Common Council of the city of New York, and by such rules and regulations as the Commissioner of Public Works, his successor or successors in office, may prescribe for the laying of mains, and the proper protection and filling of the trenches or excavations, for the taking up, replacing and repaving of the pavements, and the lighting, care, and maintenance of the public lamps.

Ninth—The permission given by said resolution of the Common Council, unless sooner revoked as hereinafter provided, shall continue for the period of thirty years from the date of signing of these conditions by the Mayor, Comptroller, and Commissoiner of Public Works; provided all the conditions herein prescribed shall be fully performed by the said company. Neither said permission nor any right conferred on said company by said resolutiou shall be assigned nor transferred without the previous consent of the Common Council.

Tenth—The Common Council may repeal, annul, and revoke the said resolution, and the permission thereby given upon failure of the said company to perform any of the conditions herein contained, and thereupon all rights of said company under said resolution, and these conditions shall cease, and said company shall thereupon remove all its pipes and mains from the streets, avenues, and public places.

Eleventh—It is expressly provided that nothing herein, nor in said resolution contained, shall be construed as granting to the said parties of the second part, any sole or exclusive right or privilege, or as preventing the granting privileges similar to those hereby and by said resolution given to any other company persons, or parties whatsoever, or as preventing any person or persons from erecting in or upon his or their own premises, any building or apparatus to light with gas his or their own house, store, manufactory, or premises.

Twelfth—The permission given in said resolution shall not become operative or take effect until the said Municipal Gas-Light Company shall have signified its assent to these conditions, and its acceptance of the permission given in said resolution upon these conditions.

Dated New York, March 22, 1877.

(Signed) Smith Ely, Jr., Mayor.
John Kelly, Comptroller.
Allan Campbell,
Commissioner of Public Works.

The Municipal Gas-Light Company hereby assents to all the above conditions, and accepts the permission given by the above resolution of the Common Council of the city of New York, upon such conditions.

Dated New York, March 22, 1877.

(Signed) The Municipal Gas Light Co.,
By Chas. G. Francklyn, President.
Philip Allen, Secretary.

[seal of municipal gas-light co.]

Resolved, That this company assent to the conditions imposed by the Mayor, Comptroller, and Commissioner of Public Works, as set forth in the foregoing paper this day signed by them: and accept the permission given by the resolution of the Common Council of the city of New York therein referred to. That the President be and hereby is directed to execute the same in triplicate and affix the seal of the company thereto.

I hereby certify that the above is a true copy of a resolution passed by the Boerd of Directors of the Municipal Gas-Light Company, March 22, 1877.

[Signed] Philip Allen, Secretary.

Bell's Articulating Telephone.

Extract from the Secretary's Report, at the Meeting of the Franklin Institute, Sept. 19th, 1877.

The principle upon which the articulating telephone primarily depends for its action, was among the discoveries of Faraday—that any disturbance of the magnetic condition of the core of an electro-magnet induces a current of electricity in the coil. It is also known that if a piece of iron be made to approach or recede from the pole of a permanent magnet, the magnetic condition of the latter will be changed. If, now, we use the pole of a bar-magnet as the core of a coil of insulated wire, we have but to make a piece of iron approach and recede from the pole of the magnet to produce a current of electricity in the coil.

I will illustrate this with the aid of the galvanometer, which, as most of you are aware, is an instrument for measuring electrical currents, and consists of a small bar-magnet, called the needle, suspended within a coil of insulated wire, by means of a filament of silk, in such a manner as to swing easily. In order to make the movements of the needle apparent to the audience, there is attached to it a small mirror, from which is reflected that small spot of light on the screen.

The principle on which the galvanometer works, is that if a current of electricity is passed through the coil, the needle will tend to place itself at right angles to the wire in the coil. As it is now placed, the needle is parallel with the wire. If, therefore, I place one pole of this bar-magnet within this coil of insulated wire, and connect the ends of the latter with the ends of the wire in the coil of the galvanometer, and approach this piece of iron near to the pole of the magnet, the needle of the galvanometer should be deflected in proportion to the strength of the current induced in the coil surrounding the magnet, and you should see the spot of light move toward one side of the screen. I now do this, and, you observe, that as I place this piece of metal quickly near to the magnet, the spot of light moves toward your left; and as I withdraw the iron quickly, the spot of light moves in the opposite direction, showing that the current is reversed.

All these facts were known before Prof. Bell commenced his investigations, but it remained for him to make the discovery—which enabled him to utilize these laws in the transmission of articulate speech—that if the piece of metal, intended to change the magnetic condition of the core of the coil, was made into a thin sheet and placed in front of it, and two such instruments were connected by a line of wire attached to one end of each coil, and the other ends connected to the ground, that sounds made in front of one of these plates would be reproduced by the other.

Inside of a wooden case is placed a bar-magnet having attached to one of its poles a piece of soft iron which becomes charged with magnetism of the same sign as the pole to which it is connected, and thus, really, forming part of the magnet. Around this piece of soft iron as a core, is wound the coil, consisting of about 60 ft. of No. 38 insulated wire, the ends being carried to the binding screws. A diaphragm, consisting of a circular plate of very thin iron, is placed at right angles to, and its centre opposite, the axis of the magnet, and as near it as possible not to touch when vibrating. This diaphragm is held firmly at its edge between the body of the case and the cap, by means of the wood screw.

By placing the instrument near the mouth while speaking, the diaphragm is made to vibrate by, and in accordance with, the sound-waves in the air, producing induced currents in the coil, which rapidly change in intensity and direction. When two telephones are properly connected by a line of wire, and to the ground, the electrical currents produced in the first instrument are conducted through the coil of the second one, and produce an increasing and diminishing attractive force in the magnet, and thus reproducing the vibrations of the first diaphragm, and consequently setting up the same sound-waves in the air near it. By placing the second instrument to the ear, the voice is heard in every intonation and quality, so that one is able to recognize the speaker by his voice.

This telephone, and two others in the body of the room, are connected, through about 4000 feet of wire, to similar instruments at No. 1111 Chesnut St. I will now to single the person in attendence there, that we are ready, by means of this magneto-electric apparatus, and you will be able to hear the conversation carried on between that point and this room*

The number of instruments in the circuit seems to make very little difference in their action; wt had six or seven on the line yesterday, ond apparently could hear as well as with only two. You will observe that the sounds conveyed can only be heard by placing the instrument to the ear, and therefore that the newspaper accounts of the speaking telephones being heard by a whole audienca are mistakes.

The extreme distance through which this telephone can be used has not been definitely stated, but it has been used successfully between points 32 miles apart. We made some experiments to-day with a rheostat, and spoke through a resistance equal to 550 miles of ordinary telegraph wire, stretched on poles. While theoretically the instrument is capable of being used on a wire of that length, practically it could not be used, partly on account of the interference of induced currents from other wires, but principally because of what is termed escape or leakage, by which the current would be dissidated.

Great care is necessary in erecting lines for the telephone, for if the wire comes in close proximity to, or is carried on the same poles as, other lines, other currents are induced, producing confusion.

Part of the line we are now working on is carried on the poles of the city linei, and you can hear distinctly the click of the various Morse instruments operating them.

This telephone, the invention of Prof. A. Graham Bell, of Boston, should not be confounded with that of Elisha Groy, of Chicago, Ill., or of T. A. Edison, of Newark, N. J., both of which have been used in public for conveying musical sounds.

The two distinguishing features of the Bell telephone are that it is only one not using a battery, and that conveys articulate speech by means of electrical currents.

The Bell telephone is now in practical use in New York and Boston, and several lines arein course of construction in this city.—*Jour. Frank. Inst.*

* This was done, and conversation was carried on with almost the same ase as if the person talking were personally present. Several instruments were placed in the circuit, in different parts of the room, and each one conveyed the sound equally well. After some experiments in speaking, the telephone on Chesnut Street was placed on the sounding-board of a piano wolle being played, and the tune was heard quite distinctly by those listening at the Institute.

Contributions to the Theory of Luminous Flames.

BY DR. KARL HELMANN.

[Translated from the "Journal of Gasbeleuchtung."]

PART II.

[Continued from page 141.]

My theoretical deductions given above were to the effect that, if the heat-depriving influence of the burner and of the issuing stream of gas could be diminished or eliminated altogether, the brilliancy of the flame would be considerably increased; but the referees contradicts this also. The only supposition that will reconcile these flat contradictions appears to me to be that the whole of the experiments deal with far too minute differences of temperature. Our photometric instruments are anything but perfect, and it would be really surprising if increasing the heat of a flame, already possessing a temperature of, perhaps, 2000°, by 100° or 145°, should have the effect of producing an increase of brilliancy in any way appreciable by our photometers. Therefore, I was in no way disheartened by the negative results of the referees, as only a very great increase of the heat of the gas could be expected to have any considerable influence in augmenting the brilliancy of the light, and I was at once induced to employ glowing heat, causing the gas to escape through a red hot burner.

It has already been shown that the heat-abstracting influence of the burner might be neutralized by heating it sufficiently, and that the gas-jet would necessarily be heated at the same time. While, therefore, it is, on the one hand, impossible for a glowing-hot gas-jet to issue from a cold burner without at the same time heating the latter, and, on the other hand, equally impossible to use an incandescent burner without the temperature of the issuing gas being raised, the experiment of passing the gas through an incandescent burner yields a result equal to the sum of the two separate effects, of which neither can be estimated individually.

The experiments had to be carried out with several precautions, if the results were to be regarded as proving anything; and after it had been qualitatively demonstrated that the heating of the burner-tube produced a considerable increase of brilliancy in the light, it required to be carefully examined whether the consumption of gas experienced any alterations when the burner-tube was heated to incandescence. I have already stated that Blochmann has shown that the considerably decreased consumption of gas, when the jet is lighted, depends upon the heating of the burner-head, and it was to be expected that a red-hot burner-tube, being longer, would also occasion a diminished gas consumption. I had, therefore, constantly to take note of the exact quantity of gas consumed at the time I determined the intensity of the light. It appeared, however, that the diminution of the gas consumption with wide tubes, and, what is of greater importance, with a wide orifice, is not considerable. My experiments were carried out by causing the gas to pass through a meter, of which the indicator reading per minute gave the consumption in litres per hour. From the meter the gas flowed into a glass tube, inclined upwards in a slanting direction, over the upper end of which a tube, formed of platinum foil rolled together, was luted on air-tight. The powerful flame of a Bunsen burner was brought underneath the platinum tube, and when not in use was pushed aside, but not extinguished, so as not to alter the pressure of the gas. The readings of the gas consumed by the flame under examination, and the arrangement of the photometer, took place with the precautions already enumerated.

After the measurement and register of consumption had been taken with a cold burner, and then with an incandescent burner, the latter was allowed to cool and again experimented with, and the results only allowed to be trustworthy if the last one coincided with the first. Of course, during the whole series of observations, the position of the taps, of the burner-tubes, etc., remained quite unaltered.

Two platinum tubes, of 10 centimetres in length were used, the narrowest 4 millimetres, and the widest 8 millimetres in diameter. By means of the Bunsen lamp placed below, the platinum tube was heated near the open end, in such a manner that the platinum became incandescent to the extremity, but without causing any flickering of the flame under examination. The light emitted by the glowing platinum tubes was ascertained, by direct experiment without the gas-jet, to be so insignificant that it might be disregarded.

In the following table, columns 1 and 2 give the intensity of the light, measured in stearine candles, from the cold and the heated burner tube, while 3 and 4 give the corresponding consumption of gas in litres. Column 4 gives the observed increase of light, and column 6 the simultaneous decrease of gas consumed, both calculated in percentages. To obtain comparable values for the actual gain in brilliancy, it was necessary to refer this latter element in both cases to an equal consumption of gas.

Although the relations between the brilliancy of the light and the quality of gas consumed are not yet thoroughly understood (for the researches of Silliman, Pole, Hunt, and others on this subject do not at all agree together), I think I am justified in assuming a direct proportion for the small differences of gas consumption which occur in the following table, so that where 15 litres are observed to yield 0·4 candle light, a consumption of 15·5 litres may be calculated as yielding 0·38 light. Any possible error will be less than the possible error of observation. The figures thus arrived at by calculation are noted in column 7, while in column 8 the results in column 2 are repeated for easier comparison. Thus, for instance, a consumption of 15·5 litres of gas per hour, burned from a platinum tube 4 millimeters in diameter, yielded a light of 0·38 candle against 0·6 candles, when the tube was heated to incandescence. The gain in light per cent. is shown in column 9, and is, for the present example, 57·9 per cent.

		Light Expressed in Candles.		Consumption of gas in Litres.		Increase of light per cent.	Decrease of gas consumption per cent.	Degree of light for the decreased gas consumption.		Gain in light per cent.
		Cold Burner.	Hot Burner.	Cold Burner.	Hot Burner.			Cold burner.*	Hot Burner.†	
		1.	2.	3.	4.	5.	6.	7.	8.	9.
Narrow Tube.	I.	0·4	0·6	16	15·5	50·0	3·1	0·38	0.6	57·9
	II.	2·1	2·9	38	37·5	38·1	1·3	2·0	2·9	45·0
	III.	5·6	6·1	83	82·0	8·9	1·2	5·5	6·1	10·9
Wide tube.	IV.	0·8	1·5	23	23·0	87·5	—	0·8	1·5	87.5
	V.	2·0	2·7	41	41·0	35·0	—	2·0	2·7	35·0
	VI.	4·9	7·6	123	121·0	55·1	1·6	4·8	7·6	58·3

* Calculated. † Observed, per column 4.

The results of this table may be easily reviewed if curves are constructed from the figures in columns 1 and 3, 2 and 4, as has been already explained. For a very accurate curve, further detereminations would be requisite, but for the object before us the above figures are quite sufficient.

In the first place, a considerable increase of light is perceptible in every case when the burner is heated to incandescence; then a glance at column 9 of Experiments I., II., and III. shows that the gain in intensity of light is much greater in a small flame than when more gas is consumed. The cause of this, besides the relatively smaller disilluminating effect of the burner in large flames (which is removed by heating), is clearly this, that with increased consumption in the same time a large quantity of gas passes the heated tube, and, owing to the greater velocity, is so much the less heated as this velocity of escape is greater.

The figures obtained from the wide platinum tube, however, show a deviation from this result, inasmuch as, with a greatly increased consumption of gas, the effect of the heated burner is also much greater. This, at first sight, unexpected result I explain as follows:—As is seen from Experiments V. and VI., with such a wide orifice, the gas is unfavorably situated for the development of light; thus, 123 litres of gas from a wide aperture only gave 4·9 candles, while 83 litres from the narrow tube gave 5·6 candle light. Obviously, the surface of the flame compared with its volume is much too small to permit of such energetic combustion, that the interior of the flame can attain a sufficiently high temperature; but as gas, capable of developing light, is present in abundance, increase of the flame temperature, by heating the burner-tube, will produce a great increase of light (as 87·5 per cent. in Experiment IV.).

This effect must, as has been said, diminish with increased rapidity of efflux, and this is confirmed by Experiment V.; but as, with a still larger efflux, the flame becomes flickering, and deposits soot, the intensity of the light does not increase in nearly the same ratio as at first with the increased consumption, but falls off more and more till it remains stationary, and with still greater rapidity of efflux the intensity of light actually diminishes, reaching at last, as Benevides demonstrated, zero; that is, with very great rapidity of the gas stream, the flame becomes blue.

Although the advantage of the heated burner* decreases with increased consumption of gas, the intensity of the light from a cold burner diminishes in a much higher ratio with increased gas consumption, and it necessarily follows that the relative advantage o the hot burner will again increase from a certain point. When a curve is drawn, this fact is expressed by the curve of the flame, from the heated burner at first, with small consumption, advancing far beyond the other in the direction of increased intensity; the two curves then approach each other (at about 40 to 45 litres consumption), and again diverge, the flame from the cold burner remaining considerably behind the other.

With respect to the effect of heating the tube upon the quantity of gas consumed, the Experiments I., II., and III. show, as might be expected, a diminished consumption. With a narrow tube the expansion of gas causes a greater obstruction to the efflux than with a wide tube, and for the same reason no diminution of the gas consumption was observed in Experiments IV. and V., the retarding action not becoming appreciable until the rapidity of 123 litres per hour was reached.

It would, therefore, appear to be proved that by heating considerably the issuing gas and the burner, a great increse of light is attained, and that the absence of such a result in the experiments of the Gas Referees is owing to the difference of temperature employed by them not being sufficiently great to become apparent in the photometer.

It seemed desirable also to examine the action of flat expanded flames, issuing from slit apertures, and the narrow platinum tube was so far compressed at its open end that only a very small slit remained, and the flame became flat. The results from this burner were as follows:

* I suspect, however, that the intensity of light from a wide aperture will have a second maximum point, as the rapid stream will draw more air into the flame, thus causing more active combustion. But this will depend greatly on the flame.

		Light Expressed in Candles.		Consumption of gas in Litres		Increase of light per cent.	Decrease of gas consumption per cent.	Degree of light for the decreased gas consumption.		Gain in light per cent.
		Cold Burner	Hot Burner.	Cold Burner.	Hot Burner.			Cold Burner.*	Hot Burner.†	
		1.	2.	3.	4.	5.	6.	7.	8.	9.
Narrow platinum tube compressed to form a slit opening.	VII.	1·3	2·2	38	35·0	69·2	7·8	1·2	2·2	83·3
	VIII.	2·6	3·5	55	51·5	34·6	6·3	2·4	3·5	45·8
	IX.	4·7	5·8	90	81·0	23·4	10·0	4·2	5·8	38·0

* Calculated. † Observed, per column 4.

Here, again, it appears that by heating the burner a considerable increase of light is attained, which, as in the former experiments (I., II., and III.), is generally greater as the quantity of gas issuing from the burner is less. Especially remarkable, however, is the much diminished gas consumption with the heated burner, evidently because with a narrow orifice the action of the expanding gas on the rapidity of the jet was much more effective than it would have been with a wide orifice and wide tube.

In a former experiment, when causing a blue flame from a mixture of coal gas and carbonic acid gas to become luminous by heating the burner tube, I had observed that the desired result did not take place if the burner tube was heated further back, some centimetres from the open end. The reason for this appeared to be the cooling effect of the portion of the metal tube which the heated gas had still to pass, as was proved by several experiments.

It was obvious that a similar result might be looked for with the platinum burner when experimented with for the purpose of intensifying the light of unmixed coal gas by heating the burner tube, and accordingly it appeared that the effect produced depended, in a great measure, on the position of the heating flame. To obtain numerical results on these points, the gas consumption and light-yield of the gas-flame from the narrow platinum tube were determined; the tube was then heated to incandescence*, as near the orifice as possible, and the consumption and strength of light again noted; and then, after cooling the tube again, the heating flame was placed further back, leaving about 4 centimetres between the heated portion and the orifice.

The question now arises—Is the increased intensity of the light, when the burner-tube is heated, merely a consequence of the direct addition of heat to the flame, or do any chemical processes bear an important part in the result?

The experiments last cited indicate that the addition of heat in itself is the principal factor; because for effecting a chemical change of the constituents of the gas by the heat into combinations capable of yielding more carbon in the flame, it must obviously be a matter of indifference what part of the burner is heated. In order, however, to arrive at a more certain conclusion, it was necessary to observe the effect produced on the light-intensity of a gas which had passed through a red hot tube, and been afterwards cooled down to its normal temperature. The experiment was so arranged that the gas, after leaving the meter, first passed through a platinum tube, which could be heated to incandescence by means of a powerful Bunsen lamp. From this the gas passed into a worm immersed in water at 15°C. At the other end of the worm was fixed a slit burner of steatite, from which the flame burned. The experiments with this apparatus showed either no difference at all in the intensity of the light, or such a slight diminution that the difference might be regarded as due merely to errors of observation.

One might, perhaps, suppose that, though a fresh combination of denser, more light yielding hydrocarbons was formed, its illuminating effect was neutralized by a simultaneous deposit of carbon in the platinum tube; but even after prolonged experiments, the deposit of carbon in the interior of the heated tube was quite insignificant. If it were assumed that the force of the gas stream carried away most of the deposited carbon, it would still be deposited lower down in the cooling worm, or else the gas escaping from the tube would exhibit a smoky or sooty appearance; but nothing of the kind was observed.

Other special experiments showed me that a decomposition of the gas used, and deposit of carbon on passing through a heated tube, only took place to an unexpectedly small extent, as even a very slow gas-stream, yielding only a minute flame, after traversing a strongly-heated tube of refractory glass for a considerable time, left scarcely any visible traces of a carbon deposit.

Possibly the low heat-conducting power of the gas may contribute to this, but the quantity of carbon deposited in gas retorts is probably attributable far less to the marsh gas and the ethyl gas than to the denser hydrocarbons or tar vapors, which are far more readily decomposed so as to deposit carbon, even with a moderate red heat, than the former which require a much higher temperature.

As the purified coal gas for household use contains little or none of these dense hydrocarbons and tar vapors, it is not surprising that the deposit of carbon in the platinum tube was in such small proportion.

In the worm, cooled down to 15° C. by water, drops were gradually collected, consisting partly of water, and partly of a yellowish-brown tarry liquid; as this collection only appeared when the platinum tube was heated to redness, the deposit cannot be a condensation of vapors formed as products of decomposition in passing the heated tube. The quantity of the deposit was, however, so insignificant that it could not possibly have any material influence on the light. To ascertain whether any volatile hydrocarbons, such as benzole, etc., were to be found in these products of condensation, I caused pure hydrogen gas to be passed through the worm after the conclusion of the experiment, but the issuing gas (after expulsion of the coal gas) always burnt with an almost invisible flame, and even heating the few drops of liquid in the worm produced no illumination in the hydrogen gas.

I do not think, however, that these results can be considered as of universal application, but that they would be materially influenced by the quality an composition of the gas used.

The considerable increase of light in the former experiments, when the burner tube was heated to incandescence, cannot, after what has been said, be ascribed to any decomposing effect on the gas, within the tube itself, otherwise the gas, when cooled down to its original temperature, should still exhibit increased brilliancy. The direct addition of heat therefore remains as the sole, or at any rate greatly preponderating cause to be assigned for the increased development of light.

Let us refer to the object which these photometric observations were originally intended to attain—the reason for undertaking them. It was a question of determining the obstructive action of the cold burner tip, and of the cold gas entering the flame, and of proving that this deteriorating influence on the light may be removed by previously heating the gas and the burner. The same idea probably guided the inventors of various new burners, which, according to the descriptions, are all more or less advantageous from the gas being heated before it is consumed. As an instance, I may mention Cremin's burner, in which the gas first passes through a cylinder surrounding the burner tube. This heats itself from above downwards, and warms the gas before passing into the flame. Cremin's is said to yield 60 per cent. more light than a fish-tail burner.

This kind of burner, however, can only warm the gas slightly; and the warmth which, according to the explanations already given, serves to diminish the cooling effect of the issuing gas stream—that is, to raise the temperature of the flame—is itself, in this class of burners, abstracted from the flame; for the flame heats the burner, which conveys its heat to the cold gas stream, and so is constantly being cooled again. The burner tube being thus kept at a low temperature, the cooling effect upon the flame must be so much the greater. On the one hand, heat is taken from the flame, and on the other returned, though, of course, with considerable loss by the way, through the heated gas. The *rationale* of such a burner appears to me to be somewhat peculiar.

I will not, *a priori*, dispute that such burners may, under special circumstances (such as high pressure, etc.), be advantageous, but I do not admit that heating the gas in such a way is the cause of the increased light. In these cases other causes, of which diminished velocity of efflux is a prominent one, must be looked to for the increased intensity. Burners, whose utility depends upon previous heating of the gas, should be so constructed that the gas is heated, not by the light-flame itself, but by the hot products of combustion, or by an independent source of heat, such as a Bunsen heat-flame. Whether in the latter case the additional cost would be more than compen

		Intensity of light in Candles with			Consumption of Gas with			Increase of light per cent*	
		Cold Burner.	Burner Heated.		Cold Burner.	Burner Heated.		Burner Heated.	
			Close to the Orifice	Further back		Close to the Orifice	Further back	Close to the Orifice.	Further back.
Narrow platinum tube.	X.	0·4	0·9	0·6	19	19	19·0	125·0	50·0
	XI.	2·0	3·4	2·8	48	46	44·5	78·9	55·5

* Reduced to equal consumption of gas. The diminished consumption was calculated for, as in the previous experiments.

These experiments prove that a much less effect is produced if the burner-tube is heated, not close to the orifice, but a short distance backward. The gas consumption in the latter case diminished rather more considerably than usual. The much greater proportionate increase of the intensity of the light from a feeble gas-jet with a heated burner than from a larger consumption, agrees completely with the results of the previous tables; the explanation of the exceptional excess, when the burner is heated in the middle, as shown in the last column, is probably that the rapid gas stream parts with relatively less heat to the succeeding unheated portion of the tube than the slower stream does.

The maximum degree of light is, therefore, attained when the front portion of the burner-tube, next to the orifice of issue, is heated to incandescence. Not only is the cooling of the heated gas stream avoided, but also the refrigerating effect of the orifice of the cold metal burner on the flame itself. The higher effect is, therefore, the result of a double cause.

* The heating-flame could not be brought quite close to the light-flame, or the latter would burn unsteadily.

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sated, or even balanced, by the increased light, is a different question.

It has been proved above that the increased light, when the burner tube is heated, is not, or only in a very slight degree, owing to any chemical recombination of the elements of the gas, and, therefore, the addition of heat must be taken as the cause of the brilliancy.

At the first glance the action appears to be simply that the carbon separated in the flame attains a higher temperature, emits more light, and in consequence the brilliancy of the flame increases. But looking more closely at the flame when the burner is red hot, it shows that, while the luminous portion of the flame certainly emits a more intense light, becomes more brilliant, a considerable increase of the luminous envelope of the cone may also be clearly perceived. While this portion usually begins at a certain distance from the orifice, and then merely surrounds, as a thin yellow layer becoming thicker towards the top, the lower and interim dark portion of the flame; by heating the burner the luminous envelope at once becomes much thicker towards the interior, and extends downwards almost to the burner. The blue portion of the flame directly above the burner, which is pretty large with a cold burner, becomes part of the light-cone.

As the flame owes its brilliancy to the suspended incandescent carbon, and as it increases against the gas-stream, this increase must arise from the heated burner, causing the carbon to be sooner liberated in the flame than would otherwise be the case. Increase of intensity of the light of the glowing carbon particles, and earlier liberation of these latter in the flame are, therefore, the effects produced by heating the burner tube; the sum of both effects is the increased intensity of the light exhibited by the photometer.

But the character of a flame is obviously determined, not only by the total light-strength, but in a great measure also by the intensity of the light—*i. e.*, by the amount of light emitted by a single elementary particle of the light mantle.

It appears to me that far too little attention has hitherto been given to this relation, so important to the correct determination of a flame. The photometer, it is true, shows no distinction between a small but intense light-mantle, and one larger, but less brilliant, but the eye looking direct at the flame does, being dazzled by a small concentrated flame, while it can gaze undisturbed on a larger flame emitting an equal total of light. Here, then, is a material and important difference between the sensibility of the eye and that of the photometer. But even the photometer may be made to exhibit the difference, if the flame is not examined as a whole, but only a small portion is made use of, by means of a screen with a narrow carefully measured aperture. I may possibly have an opportunity hereafter of testing a number of flames photometrically in this way: at present I will only remark that there is in commerce a very bright burning petroleum, which is much burned, notwithstanding its high price, because people are attracted by the dazzling brightness of the flame; yet the total effect observed by the photometer is far less than that from the ordinary low-priced petroleums, which yield a larger flame with equal consumption.

In order to distinguish clearly by name between these two effects, I propose to term the quantity of light emitted by the individual particles of the flame the *intensity*, and to designate the total result of all the luminous particles together—that is, of the whole flame—the luminosity.

If all light particles possessed equal intensity, the "luminosity" would be the product of the "intensity" of the light, and the volume of the light mantle. But as this is not actually the case, it is by no means a matter of indifference in photometrical experiments to which portion of the flame the aperture of the screen is directed. Certainly, in every case, the brightest particles are to be chosen—that is, the screen should be so placed that the greatest possible quantity of light falls on the diaphragm. The numerical results will then, strictly speaking, apply only to the brightest portion of the light-mantle; but it is just this portion which is of most importance in judging of a flame.

The increased luminosity of a gas-flame, by early separation of the carbon, may be produced, not only by heating the burner or the lower portion of the flame, but also by other chemical processes. The further discussion of these processes will at the same time afford additional proof of the assumption that carbon exists in a solid form in the luminous flame-mantle.

The following is a recapitulation of the chief deductions in the foregoing articles—

A cold body introduced into, or close to a luminous flame, suspends the process of combustion in its immediate vicinity by its cooling action; but it also arrests the development of light over a much larger area.

In general, carbon containing light materials will burn with or without a separation of the carbon—that is, the combustion may be luminous or non-luminous (blue), according as the temperature of the flame reaches a sufficient height for the entire consumption of the material or not. Combustibles diluted with indifferent gases require a higher temperature to effect this decomposition than would otherwise be the case.

A deposit of soot, on an object in contact with a luminous flame, is not a consequence of cooling, for lowering the temperature of the flame does not increase, but diminishes or prevents the separation of the carbon.

Soot may also be deposited on a glowing hot surface, but it is quickly consumed when exposed to the air. As air can never be entirely excluded, the deposit of soot on a hot surface will always be less than on a cold surface. The surface on which the soot is deposited simply acts as a rampart which receives bullets fired into it.

Burners formed of a good heat-conducting material, such as iron, prevent development of light in the lower portion of the flame to a greater degree than steatite burners, the difference in the light-strength (not in itself considerable), is clearly perceptible when the burner is artificially cooled.

The burner-head and the cold gas entering the flame deprive it of much heat, especially in the lower portion, and are the causes of the light-mantle only commencing at some distance above the burner. If this latter is heated to incandescence, and the gas stream thereby also heated, the luminosity of the flame, with equal consumption of gas, increases considerably, and the more in proportion as the gas consumption is smaller. Any possible change in the chemical composition of the gas is of no importance, as the gas stream, when cooled again, no longer exhibits any increase of light.

The heat supplied by warming the burner tube acts in a two-fold manner; it increases the intensity of the light-mantle, and enlarges it considerably downwards. The carbon is, therefore, not only sooner separated in the flame, but glows much more intensely. The eye distinguishes both actions; the photometer only gives the total effect.

In judging a flame, it is very important to ascertain not only the light-strength of the whole flame—the "luminosity"—but also the quantity of light emitted by an elementary particle of the luminous flame-mantle, and which has been termed above "intensity." For practical purposes (comparison of various light-sources, etc.), besides the total luminosity of the flame, the degree of light should also be determined, which, from the brightest portion of the flame, passes through a narrow, carefully-measured aperture, in a screen interposed between the flame and the photometer. The figures thus obtained may be taken as approximate values for the relative "intensity" of the light from the brightest zones of the flame.

Hudson River Tunnel.

The work upon the tunnel under the Hudson river between Jersey City and New York, which has been delayed for some time by litigation, it is now stated will be resumed early this fall. A shaft twenty eight feet deep has been dug at the foot of Fifteenth street Jersey City, and this depth will be increased twenty feet. From this as a starting point, the tunnel will proceed in a northeasterly direction under the Hudson river and the Christopher street ferry slip. The entrance on the New York side will be in the neighborhood of Washington square. From Jersey City the grade will descend two feet in every hundred feet, until a point 2,700 feet from the New York side is reached, when it will begin to ascend at the rate of one foot in every hundred feet. The tunnel will be two miles in length, with a road-bed twenty-three feet wide, and two separate tracks. Through its entire length it will be lighted by gas. The wall will be constructed of brick, with a thickness of four feet. At no point will the top of the tunnel be less than 35 feet below the surface of the water, and in many places it will be seventy feet below. One hundred and twenty laborers will be engaged in the construction of the tunnel.

The work will go on during the whole of the 24 hours, the force working in three relays, of eight hours each.

Although the tunnel will be used for the conveyance of passengers, its main object will be the transportation of freight to and from the great railroad lines which terminate in Jersey City. The capital of the company is $2,000,000.—*Engineering News.*

Fowne's Manual of Chemistry.—Messrs. J. and A. Churchill are issuing a new edition of Fowne's Manual of Chemistry. The rapid development of the science of chemistry having caused a steady increase in the bulk of this work, it has been determined to divide it into two volumes, each complete in itself. The first volume, which is already published, will henceforth be known as "Fowne's Physical and Inorganic Chemistry," the second as "Fowne's Organic Chemistry." The work continues to be under the able editorship of Mr. Henry Watts, F.R.S.—*Chemical News.*

Gas-Light Intelligence.

United States.

Supply of Gas for West Troy, Troy, N. Y.—It is said that a Maine Gas company is considering the expediency of supplying the village of West Troy, N. Y., with gas at popular rates—*Eng. News.*

Terre Haute, Ind., to be Lighted with Gasoline.—Terre Haute, Ind., will hereafter be illuminated by gasoline. There are 305 gas posts in the city. The city will save $4,000 per annum by the change.—*Eng. News.*

A Substitute for Gas.—The recent experiments made in Paris with the "Candle Jablochkoff" have proved so successful that owners of gas stock may become alarmed, for it is claimed that a substitute for gas may be procured, which, under the most favorable conditions, will be three times cheaper than gas. It is adapted to indoors and outdoors, is inexplosive, odorless, without flicker and preserves the original color of the articles which it illuminates. It in no way resembles any of the electric lights previously introduced, and its cost is said to be reduced to one-fifteenth of the cost of gas in manufactories having hydraulic power. The candle used lasts an hour or two, and is replaced by an automatic arrangement, thus securing light for any length of time desired.—*Eng. News.*

Reducing the Price of Gas at Jacksonville, Ill.—At a meeting of the directors of the Jacksonville Gas Light and Coke Company, held September 22, 1877, it was resolved that the price charged for gas should be reduced 50 cents per 1,000 feet on and after October 1st. Wm. Thomas, Sec'y.

Let There be More Light.—We would call the special attention of our readers to the deduction made in the price of gas by our gas company, as announced in another column. Mr. King assures us that it is the policy of the company to reduce the price as fast as it can get consumers to warrant so doing. For this purpose the company is extending its pipes largely this summer. It also expects to make every inducement possible to parties proposing to fit up for the use of gas. Now that the company has manifested this spirit, let citizens take hold and do all that they can to have the pipes extended to all parts of the city, not only that they may secure a further reduction, but also that they may show an appreciation of what the company has done and will continue to do.—*Ill's. Evening Courier, Sept. 22nd.*

Stealing Gas.—How Mr. Kelly Attempted to Economize, and How it Resulted.—One John Kelly, who resides at No. 105 Hanover Street, was arraigned before the police court, yesterday morning, on the charge of making a connection with the pipes belonging to the People's Gas Light Company. Kelly has been living at this number since about the 1st of July, previous to which time the meter had been removed from the house. Kelly concluded that he would not trouble the company, and took upon himself to make a connection by joining the ends of the pipes and winding the joints with rags which he covered with soap to prevent the escape, and then turned on the gas from the street. Just how long he had been using it is not known, but Mr. Lewis, the Secretary of the Company, suspecting something wrong, took occasion to look into the matter, and together with Detective Laubscher, took a stroll in that vicinity on two or three evenings and at each time the house was brilliantly lighted. An information was made, and armed with a warrant they called on Mr. Kelly, about 9 o'clock Wednesday night, and escorted him to the station. He pleaded guilty to the charge and through the leniency of Judge Updegraff, it being the first offense, he was fined $25 and costs, and committed till paid.

The law provides as a penalty for this kind of offence, or for making any connection whatever with the pipes of a company or in any way conducting the same around a meter, a fine not exceeding $250 or thirty days imprisonment, or both at the discretion of the court.

Without such a law the Gas Companies would be left entirely to the mercy of just such fellows. This should prove not only an example, but an assurance to the public that every such violation of the law will be followed by the full penalty thereof.—*Weekly Ohio State Journal.*

Fixing the Salary of Gas Receiver Newman.—*He saves* $60,000 *a year by stopping leaks, and experts say he ought to get* $25,000 *for a year's work.*—Jupge Gottschalk held Court yesterday, and Judge Madill, attorney for Gas Receiver-Newman, presented an application for compensation for the Receiver for the year ending in June last. No amount was named but several witnesses were examined as experts, and testified to the value of the services rendered. City Counsellor Farish was present as the representative of the city.

Mr. Soc. Newman took the stand, and testified that he was native here and to the manor born, October; he had been in business since he was twenty years old; at one time carried on a large manufactory of gas pipe; built the Hannibal gas works complete; furnished material for the Peoria and Quincy works; also pipes for the St. Louis gas works; took possession as Receiver of the St. Louis gas works June 5, 1876; gave up everything else; devoted his whole time and attention to the duties of his Receivership; did a great deal of night work; took charge of the lamp-lighting; the lighting had been done by Fruin & Company; took charge of it on September 1st, 1876; at first the city paid him $7 per lamp, the same that Fruin was getting; then $5 per lamp; the profit to the city was $6,000 a year. Made arrangements to light the lamps in half an hour, instead of three-quarters as before, and thus saved 2,000,000 feet of gas. There were 3,400 lamps, and he saved $2.50 per lamp. Saved half an hour per day in lighting and extinguishing; in this way saved between $11,000 and $12,000 gross. Took the contract for hauling the coke, and saved $4,500 per annum; used the coal tar for fuel, and saved $400 per month; saved $1200 a year in the use of water, and $3,183 in lime; made 24,000,000 feet of gas more than was made the previous year, and the quality was one candle power better. Have about 120 men employed regularly at the works. Saved 7½ per cent. in the purchase of meters. Value of the works, $1,300,000. About 225 men and boys employed. Laid a mile of mains during the year. Gave a bond of $350,000;

HANDLED $800,000 CASH;

make monthly reports to the Court; the old company paid $5,000 to the President as salary, $4,500 to the Secretary, and $5,000 to the Superintendent; the last-named had interest in the contracts, and made $12,000 besides his salary; have performed the duties of President; have a cashier at $2,500 a year; loaned to the city and to banks the money received; the interest goes to the trust; paid out about $307,000 for expenses; have $150,000 on hand now; saved in all about $57,000, according to his report, but in reality more; about $328,000 is the profit on the works for the year; profits reported by the company for previous year $310,360, but $347,000,330 shown by the books: the price of gas was reduced 50 and 75 cents per 1,000 feet under his administration.

GERARD B. ALLEN

stated that he had for a long time had charge of large numbers of men, engaged extensively in manufacturing. Heard Newman's testimony; think his services worth—in view of his having saved $60,000 to 70,000—fully 25,000. Witness owns 350 shares of gas stock, and had watched the management of the works under Newman. Look at Newman's services in the light of his economical management, and as having taught a practical lesson in the running of the works. If the company had known what Newman has taught them there would have been no difficulty between the city and the company. Aside from this view of the case, witness could not estimate the value of the Receiver's services; no idea what such agents get.

Judge Joseph O'Neill estimated the Receiver's services for the first year at $20,000 to $25,000; subsequent years, $15,000.

Theophile Papin concurred with preceding witnesses. Presidents of large moneyed corporations are paid from ten to twenty thousand dollars a year. Cannot pass on the value of Newman's services generally; do not know his means and capacity for making money.

S. M. Dodd, of the extensive dry goods house of Dodd, Brown & Company, said he had over 100 men in his employ: he thought Receiver Newman was entitled

TO 2½ PER CENT.

on the receipts; that is the rate paid to agents of large manufacturing establishments, cotton mills, etc.

F. Boeckler, the heavy lumber dealer, thought the receiver should be allowed $25,000.

Charles F. Meyer, in the jobbing and insurance business, said, all things considered, $12,000 would be fair compensation; don't think any officer of a large corporation here gets that much; some Bank Cashiers get $6,000, and their work is harder than that of the Receiver; don't think that the fact that gas is manufactured entitles him to more pay; other men make the gas; if the Receiver was not competent he would not have been appointed.

D. H. Naylor, Cashier of the Real Estate Bank, expressed himself as in favor of the twenty-five thousand dollar figure.

N. Schaeffer, President of the Phœnix Brewery, and for thirty-eight years an extensive manufacturer of soap, candles, etc., said he agreed with Mr. Allen in his estimate of the Receiver's services for the first year. Considering the large bond and the receipts and disbursements, $25,000 was little enough.

J. McGrath, architect and builder, considered 3 per cent. on the receipts about right.

Arthur Kempland named $25,000.

S. McCormick, ex-Water Commissioner, had been in the city twenty years, and thought 3½ per cent. not too much.

City Engineer Pfeiffer testified in regard to the lighting of the lamps, and the matter was taken under advisement by Judge Gottschalk—*St. Louis Globe-Democrat.*

The Engineering News of Chicago, thus speaks of Itself.—Starting as Engineering News did at a time of great depression, it has received a cordial support from the profession which, considering the times, could hardly have been expected. When many engineers have found it so difficult to obtain work, that they have been obliged to seek other means to gain a livlihood, when the sum charged for this paper has seemed of more importance by far than in years of better business, and when people have felt the need of reducing their expenses to the lowest point, the steady growth of our subscription list has clearly indicated that the News is filling a needed place in the current literature of our profession and is indispensable. In our personal intercourse with engineers and contractors, and from the reports of our agents, we get the same story, one of hearty approval and good wishes for the future.

[This is a most excellent paper and is deserving all the success with which it has been attended and we trust it may have an increased success in the future.] —Ed.

Experimental Composition of Light.—Wm. Terrill arranges seven lanterns, with glass sides stained to imitate the different colors of the spectrum. By turning the lanterns so that the projected circles, overlap, a circle of white light is produced. Interesting experiments with complimentary colors may be performed in the same way.—*Nature.*

Chemical and Scientific Repertory.

PREPARATION OF OXYGEN.—M. Zinno prepares oxygen on the large scale by causing permanganate of potassium to react on binoxide of barium diluted with water.—*Eng. News.*

CARBUNCLE.—Carbuncle is traced by M. Koch to the introduction of bacteria into the system by stinging-flies. They obtain the poisonous germs from putrescent carcases.—*Eng. News.*

THE ARKANSAS TRAVELLER.—The Lawerence (Kan.) *Journal* says: "The Searcy railroad in Arkansas consists of four miles of wooden rails laid on a natural roadbed. The equipment is one car; the working force is one man: the motive power is one mule; and the fare from the outside world to Searcy is $1. There was no strike on the Searcy railroad."—*Eng. News.*

MEXICAN RAILWAYS.—The Minister to Mexico has transmitted to the Department of State a report upon the railroads of that country. American cars and engines are superseding the English. The want of railroads is acutely felt throughout Mexico, and the subject of concessions for their construction will be a leading topic at the next session of Congress.—*Eng. News.*

ARTESIAN WELL BORING AT ST. LOUIS.—In boring the artesian well at the Insane Asylum, St. Louis, the auger penetrated 3800 feet, going through 200 feet of coal measures, 500 feet of sub-carboniferous limestones 1,000 feet of Devonian, and 2,000 feet of upper and lower silurian, and in the bottom cut a brown ferruginois sandstone, supposed to be of Potsdam age.—*Eng. News.*

SUBTERRANEAN TELEGRAPHY.—Subterranean telegraphy is receiving much attention in Europe. Germany has seven underground lines between its capital and its western frontier, and recently another one on a great scale has been laid between Berlin and Mayence. The cost of these underground cables is about six times more than the overground wires, but the advantages are considered much greater and in time of war are invaluable.—*Eng. News.*

NEW APPARATUS FOR THE ESTIMATION OF FIRE-DAMP.—M. J. Coquillion has invented a novel apparatus the purpose of which he gives us the principle, but not the details. Having observed that hydrogen and all hydrocarbons in the gaseous state may be completely burned in the presence of oxygen by the introduction of a heated wire of pallidum, and that all gaseous oxygen compounds are similarly affected in the presence of hydrogen, he substitutes this agent for the electric spark in the eudiometer. It has the further advantage of causing but little explosion. He remarks that the present method of detecting fire-damp by means of the safety-lamp, which indicates the presence of the gas by a blue halo surrounding the flame, only when the fire-damp exists in the proportion of 6 to 8 per cent. in the atmosphere, is very unsatisfactory; because, when present in such large quantities, the risk of an explosion is imminent.—*Exchange.*

An Electrical Apparatus for noting overstrain or weakness in bridges or other structures, has been patented by Mr. John Forbes, of Nova Scotia, which is thus described: The invention consists in attaching upon each member of the structure an insulated wire or conductor, so arranged that an electric circuit may be made or broken by any mechanical means, by the abnormal condition resulting from the excessive strain or dislocation of parts, from whatever cause it may arise, through which a motion either in the substance of the member itself or between contiguous and adjoining members has taken place, the closing or rupture of the circuit to be indicated by an annunciator, operated by the electric current from a battery through electro-magnets suitably arranged, the armature of the magnets being so adjusted that, as in the case of hotel call-bells, a number or indicator shall be exposed, said number to indicate a particular part or member of the structbre.—*Polyt. Review.*

The Keystone Bridge Company, of Philadelphia, has received the intelligence that it is the successful bidder for the building of a wrought-iron bridge over the Ashtabula River, on the line of the Lake Shore Railway, to take the place of the one on which the terrible disaster occurred last December. The Keystone Company was not the lowest bidder, but its plan, it seems, is considered the best. The bridge is to be a single span, 156 feet long, and for a double track. The style of the bridge will be the Linville truss.

Prices of Gas Coal.

The market presents no new feature—the deliveries of coal from the Westmoreland and Penn mines, on Spring contracts, progresses slowly. The falling off in the sales of these coals this year, will show a much heavier percentage than was anticipated early in the season. The exclusion of other coal companies from the market, under the agreement with the Baltimore and Ohio Railroad Company has not been as productive of benefit to the railroad companies as was expected when that arrangement was made. Combinations which have for their object the compelling of the public to buy what they do *not* want, by illegally keeping out of their reach what they *do* want, will sooner or later result in disaster to those who make them.

The attention of gas coal consumers in New York and New England, has been turned to the importation of foreign coal this year, and these will form an important item in the statistics of the gas coal trade for 1877.

Freight from the provinces have rated at about $1.75 per ton to New York and the leading New England ports, making the cost of those coals say $4.25 to $4.50 per ton delivered, while some Newcastle has been imported at 4s. and 5s. freight, or a cost of $4 per ton for the coal delivered at New York. A continuance of these prices another year must operate to prevent any material change in American coals.

With the approach of the winter months, we note an improved demand for Cannel, which is now coming forward freely from the Kanawha Valley via Richmond.

The following quotations cover the present cost of the standard gas coals, viz.:

Westmoreland	$5.50	$4.50 } at Baltimore.
Penn	5.50	4.50 }
Despard	5.35	
Marion	5.35	
Murphy Run	5.35	
Newburgh Orrel	5.35	
Ches. and Ohio RR. Caking Coal	5.40	$4.10 f. o. b. at Richmond.
Block House	4.50	1.75 } Gold f. o. b. at Mines
Glace Bay	4.25	1.60 }
International	4.25	1.60 }
Clover Hill	4.00	
Cannelton Cannel	10 00	
Peytona	10.00	

Gas Stocks.

Quotations by W. B. Scott & Co., Bankers,

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OCTOBER 16, 1877.

☞ All communications will receive particular attention

Gas. Co.'s of N. Y. City.

	Capital.	Par.	Bid.	Asked.
Central, Westchester	466,000	50	90	95
Harlem	$1,850,000	50	95	97
Manhattan	4,000,000	50	198	200
Metropolitan	2,500,000	100	128	131
" Scrip	$1,000,000	..	100	103
" Bonds	500,000	1000	92	94
Mutual	5,000,000	100	90	95
" Bonds, gold.	900,000	1000	105	—
Municipal	1,000,000	100	70	80
New York	4,000,000	100	130	135
Suburban, W'steh'str	390,000	50	—	100
Gas Co.'s of Brooklyn.				
Brooklyn	2,000,000	25	170	175
Citizens	1,200,000	20	70	75
" Scrip	220,000	1000	95	97½
Peoples	1,000,000	10	—	40
" Bonds	$ 325,000	...	—	95
" Scrip	300,000	...	75	80
Metropolitan	1,000,000	100	65	70
Nassau	1,000,000	25	80	85
" Ctfs.	700,000	1000	96	98
Williamsburgh	1,000,000	50	115	120
" Scrip		...	100	103
Union Co. E N. Y.		25	—	50
Out of Town Gas Companies.				
Bath, Maine	70,000	100		
Buffalo Mutual, N. Y	750,000	100	65	70
" Bonds	200,000	1000	95	100
Baltimore, Md	2,000,000	100	134	134
" Ctfs., gold	1,000,000		106	110
Bayonne, N. J		100		90
Brockport, N. Y	25,000	100	...	80
Citizens, Newark	918,000	50	100	105
" " Bds.	124,000	—	—	--
Cincinnati G & C Co				190
Derby of Conn	160,000	100	60	80
East Boston, Mass.		25	132	—
Fort Wayne, Ind		100	...	—
Hannibal, Mo	100,000	100	95	100
Hartford, Conn	700,000	25	184	186
Hempstead, L. I	25,000	100	...	—
Jersey City	386,000	20	155	160
Jamaica, L. I	25,000	100	...	—
Jacksonville, Ill	120,000	50	82	...
Lewistown Maine	400,000	100	50	85
Lima, Ohi,o	60,000	100	—	...
Bonds	30,000		90	
Laclede, St Louis Mo.	1,200,000	100	100	110
Long Branch		20	40	50
Peoples, Jersey City		...	120	125
Peoples of Albany	650,000	100	—	27
" Bonds	350,000	1000	--	-
Peoples of Baltimore		25	—	56
" Bonds			106	—
Perth Amboy		25	—	95
Rochester, N. Y		100	50	60
Richmond Co., S. I.	300,000	...	—	95
Woonsocket, R. I	150,000	100	100	...
Halifax N. S	400,000	40	148	150
Hamilton, Ontario	150,000	40	117½	
San Francisco Gas-Co., S. Fr'isco Cal.			111	112
St. Louis, Missouri	600,000	50	73	75
Stillwater, Minn	50,000	50	—	26
Saugerties, N. Y	15,000	100	95	100
Troy, Citizens	600,000	100	—	60
Toledo, Ohio			95	97½

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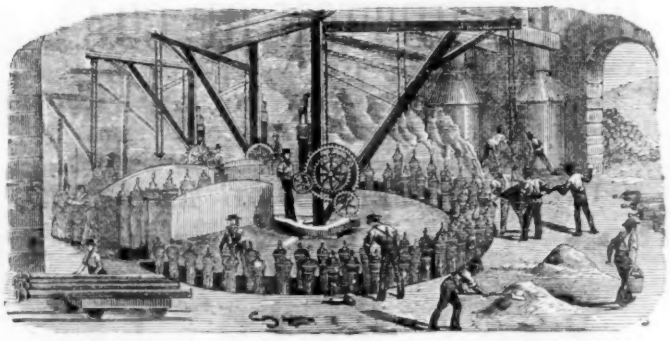

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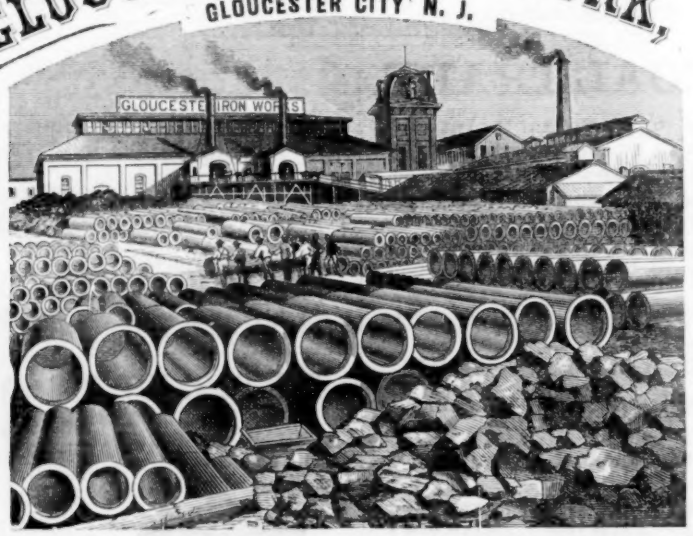

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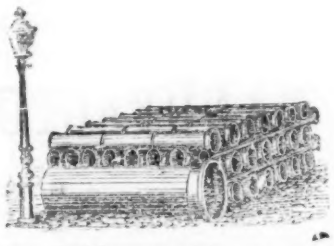

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Best dry coals shipped from Locust Point, wharves, and prompt attention given to orders for chartering of vessels.
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Among the consumers of Despard Coal, we name: Manhattan Gas Light Company, New York; Metropolitan Gas Light Company, New York; Jersey City Gas Light Company, N. J.; Washington Gas Light Company; Portland Gas Light Company, Maine

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MAXIMUM YIELD, **5.06** cubic feet of Gas per pound of Coal—A yield of **4·78** cubic feet per lb.—gave **16 14-100** Candle-Power.

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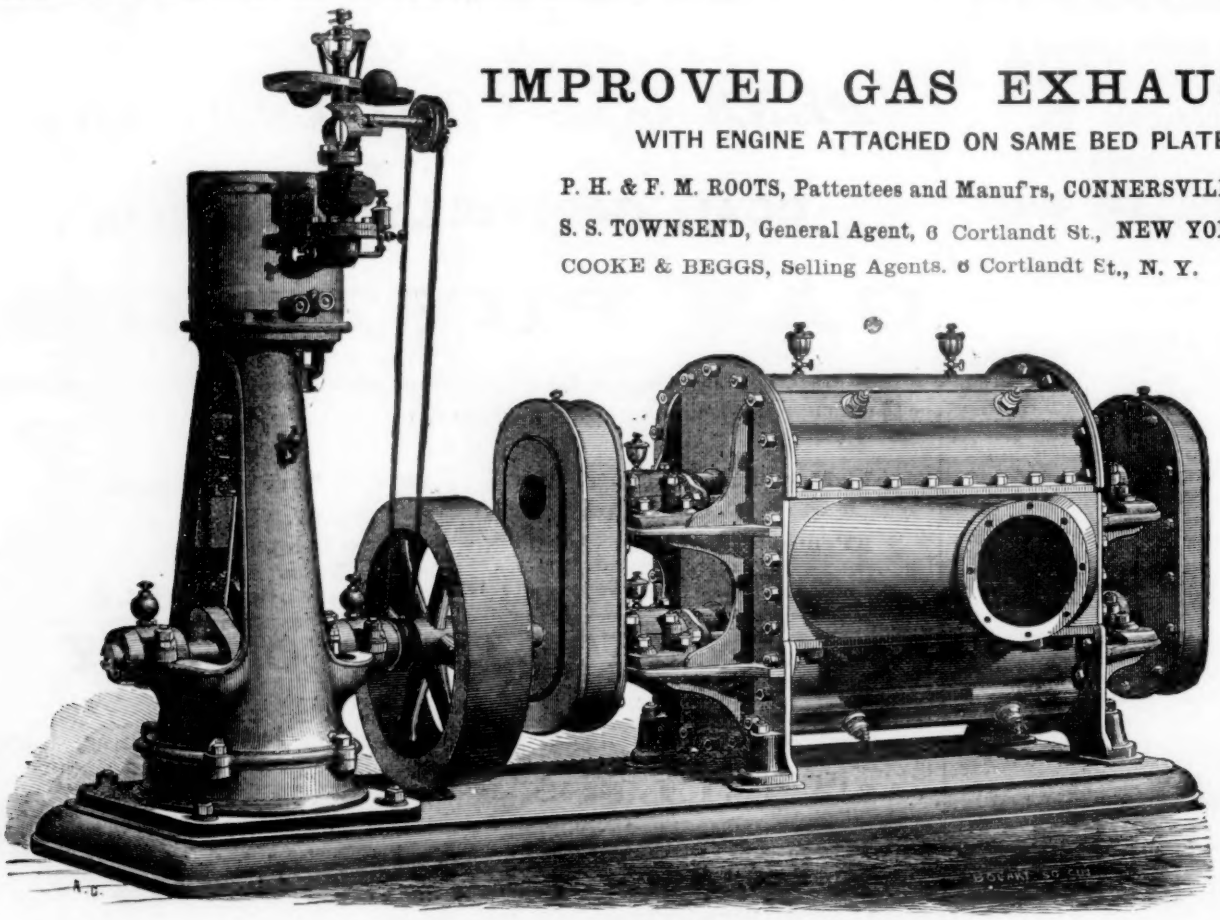

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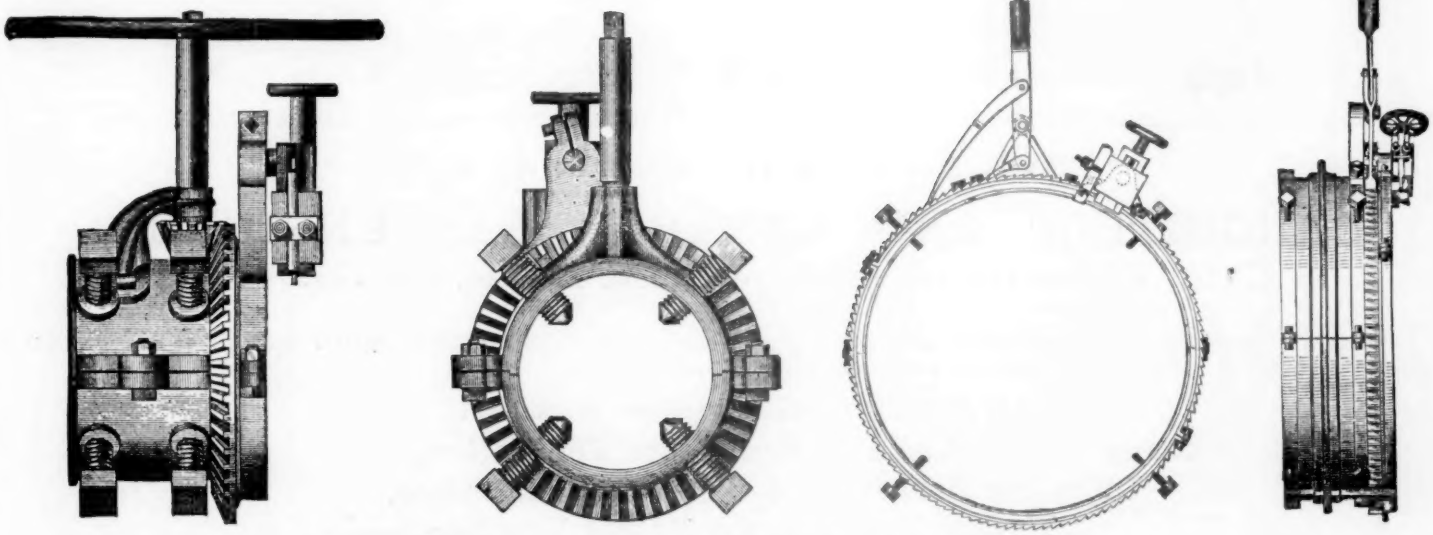

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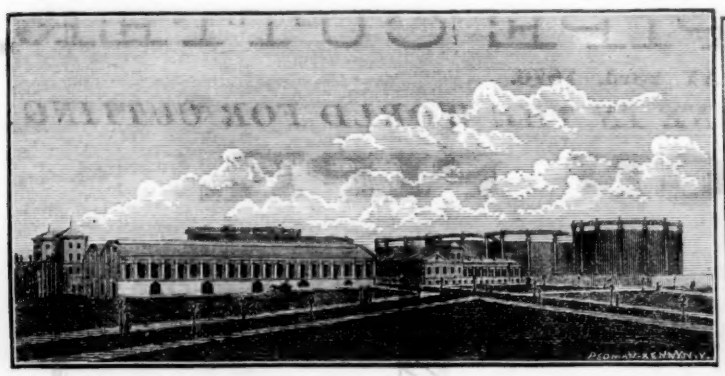

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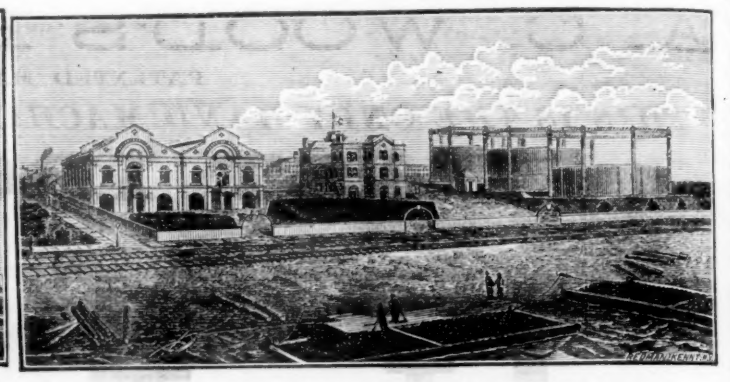

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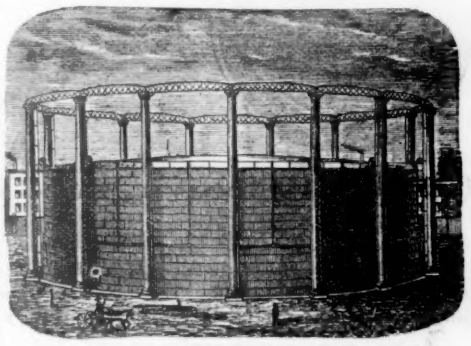

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ALL KINDS OF CASTINGS AND APPARATUS FOR GAS WORKS,

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GAS HOLDERS,

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With cast iron guide and suspension frames. GAS GOVERNORS or REGULATORS, STREET MAINS, from 1½ to 48 INCHES DIAMETER, for WATER or GAS. Street Main connections, such as BRANCHES, BENDS, DRIPS, SLEEVES, etc.

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All the Smith and Sheet Iron work required in and about Gas Works. 226-tf

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Used in the Erection of Gas and Coal Oil Works.

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INTERNATIONAL--1876--EXHIBITION.

The U. S. Centennial Commission

HAVE DECREED AN AWARD TO

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12th and Brown Sts., Philadelphia, and 49 Dey St., N. Y., U. S, A.,

FOR THE FOLLOWING REASONS:

The Exhibit consists of a Series of METERS from the Largest Size Station Meters for the use of the MANUFACTURE OF GAS, to those for the use of the ORDINARY CONSUMER. The Instruments are WELL MADE, RELIABLE as to INDICATION, and embody a number of sundry improvements which, with the general character of the Exhibit, entitle the whole to commendation.

Attest—J. L. CAMPBELL, Secretary, pro-tem.

Signed—A. T. GOSHORN, Director General

J. R. HAWLEY, President

GROUP JUDGES.

AMERICAN.

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PROF. F. A. P. BARNARD, S.T.D., LL.D., President of Columbia College, N. Y.
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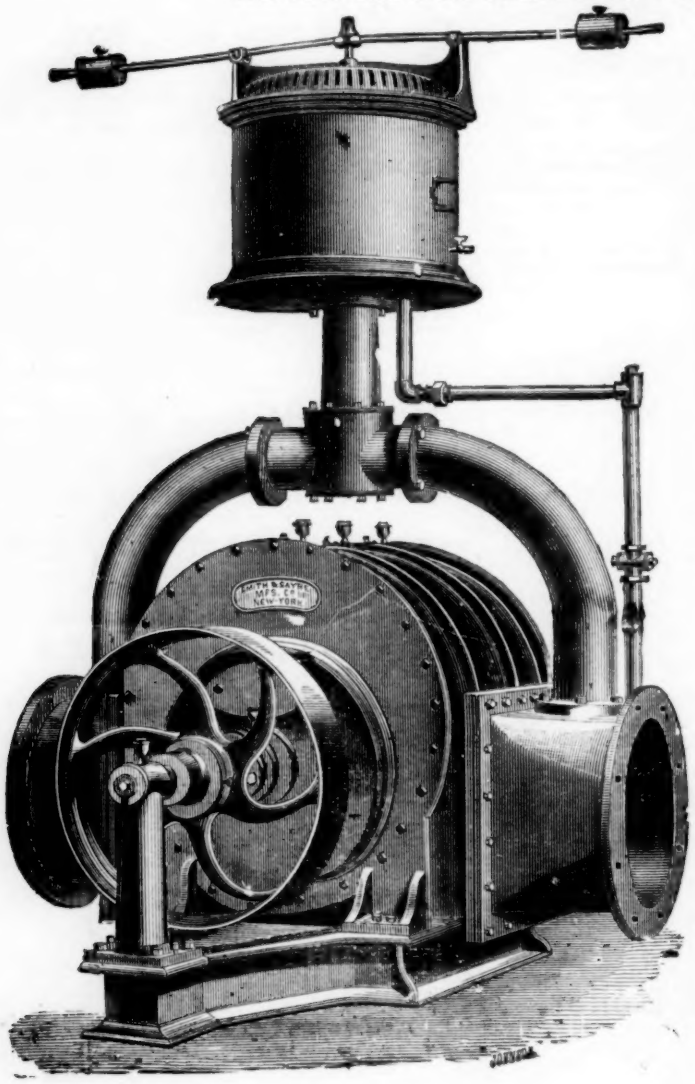
21 Cortlandt Street, New York,
PROPRIETORS AND MANUFACTURERS OF

Mackenzie's Patent Gas Exhausters.

THE BEST AND MOST RELIABLE IN USE.



ISBELL'S BALANCE VALVE COMPENSATOR and AUTOMATIC BYE-PASS are used in connection with this Exhauster, as shown in above cut.
MACKENZIE'S PATENT STEAM JET EXHAUSTER and SURFACE CONDENSER, with AUTOMATIC WATER REGULATOR.
ISBELL'S DOUBLE GATE STOP VALVES for Water and Gas.
ISBELL'S AUTOMATIC GOVERNOR for regulating Pressure of Gas in Street Mains.
Patent DEODORIZING APPARATUS for Foul Line of Purifying Boxes.
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Carpenters	0.50 to 1.50
Blacksmiths	0.50 to 1.50
Upholsterers	— to 2.00
Shoemakers, Men's	0.50 to 1.80
" Women's	1.00 to 1.50
Turners	— to 1.50
Brassfounders	— to 1.50
Farriers	— to 1.50
Silversmiths	— to 2.00
Coachmakers	— to 1.50
Harness Makers	— to 1.50
Tinmen	— to 1.00
Ornamental Plasterers	— to 1.00
Painters	— to 2.50
Stonemasons	— to 1.00
Stone Cutters	— to 1.00
Bricklayers	0.75 to 1.00
Laborers (Peones)	— to 0.37½
Quarrymen	— to 1.50
Locksmiths	— to 1.50
Ironfounders	1.00 to 2.00
Plumbers and Gasfitters	2.00 to 5.00
Engine Drivers	4.00 to 5.00
Stokers	1.00 to 1.50
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To manufacture Wet and Dry Gas Meters, Station Meters, Experimental Meters, Meter Provers, Centre Seals, Governors, Pressure Registers, Indicators, Photometers, and all kinds of Gas Apparatus; Also furnish all other Articles appertaining to the use of Gas Works.

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A. M. CALLENDER & CO.,
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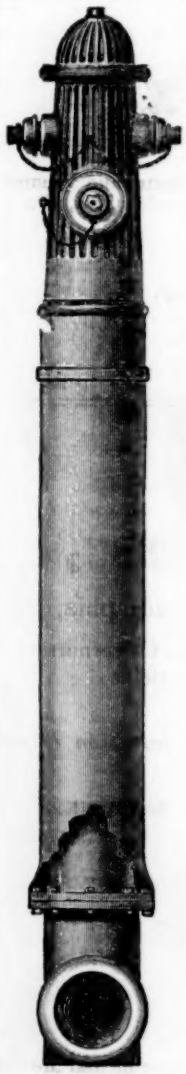

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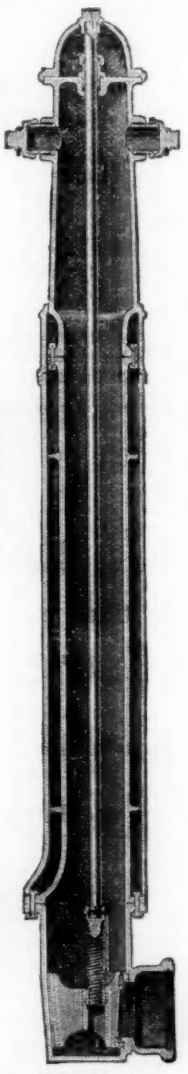

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They afford a direct passage the full size of the pipe. The seats are made of an alloy similar to BABBITT metal, specially prepared for the purpose, and superior to all other metals used for the seats of Gas Valves, as it does not corrode.

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Waltham Gas-Light Company,	"
Chelsea Gas-Light Company,	"
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Lawrence Gas-Light Company,	"
Lowell Gas-Light Company,	"
Lynn Gas-Light Company,	"
Springfield Gas-Light Company,	"
Worcester Gas-Light Company,	Mass.
Taunton Gas-Light Company,	"
New Bedford Gas-Light Company,	"
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Plymouth Gas-Light Company,	"
Middleboro' Gas-Light Company,	"
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Louisville Gas-Light Company,	Louisville, Ky.
Cincinnati Gas-Light Company,	Cincinnati, O.
People's Gas-Light Company,	Brooklyn, N.Y.
Citizen's Gas-Light Company	" "
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